ONTARIO ECONOMIC COUNCIL
REFERENCE COPY
LIBRARY

Working Paper Series

AN ANALYSIS OF STRIKES IN CANADIAN MANUFACTURING INDUSTRIES

M.W. REDER AND G.R. NEUMANN
UNIVERSITY OF CHICAGO

MARCH, 1984

Ontario Economic Council
Toronto,Ontario

HC
117
.06
.0675
no.1/84

5903

ONTARIO MINISTRY OF
TREASURY AND ECONOMICS
JUN 4 1986
86/2201
LIBRARY

AN ANALYSIS OF STRIKES IN CANADIAN MANUFACTURING INDUSTRIES

M.W. REDER AND G.R. NEUMANN
UNIVERSITY OF CHICAGO

MARCH, 1984

Digitized by the Internet Archive
in 2018 with funding from
Ontario MInistry of Finance

https://archive.org/details/analysisofstrike00neum

AN ANALYSIS OF STRIKES IN CANADIAN MANUFACTURING INDUSTRIES

M.W. REDER AND G.R. NEUMANN

UNIVERSITY OF CHICAGO

Introduction

This report on strike activity in Canadian manufacturing is divided into three parts, plus an Appendix. The first, Overview, depicts strikes as members of a wider class of community "troubles" of which natural disasters and wars are extreme examples. We divide the methods that a community uses to protect its members against loss from such troubles as "preventive" and "compensating" and divide each of these categories again as protection is provided by the individual affected or by the government.

Protection against strike loss is predominantly preventive--i.e., limiting strike activity--and is achieved primarily by the actions of those directly affected, i.e., the bargainers themselves. As discussed in section III (Policy Implications), government does restrain striking in some circumstances, and might expand its role further if the frequency and cost were judged to be excessive. Whether government's present role in strike limitation is too large or too small (i.e., whether it provides sufficient protection against strike losses) is beyond definitive appraisal. But such appraisal as can be made requires measurement of the actual loss resulting from strikes.

We have made such measurements for the first time, and report them in section II. They refer to U.S. as well as to Canadian three-digit manufacturing industries and provide cross-country comparisons of expected cost per strike in identical SIC three digit manufacturing industries, as well as cross-industry differences within countries and overall differences between the U.S. and Canada. If we cannot yet say that strike losses in Canada are too high, or too low, we can say with reasonable confidence that they are, by and large, smaller than in the U.S. for the same industry, and offer informed guesses as to the reason.

Section II is a topical summary of our empirical findings and is integrated with the other two sections. The reader who is not interested in our problems, but only in our answers, may read the three sections of the text and skip the Appendix which is written for those disposed to question and criticize. Here our procedures, data sources and doubts are exposed to critical scrutiny.

I. Overview

Strikes are attention getting--striking--events. Were they routine or highly predictable, they would lose much of their news value. On any particular bargaining occasion the occurrence of a strike is a matter of chance and corresponding uncertainty, but when aggregated over a large number of contract negotiations, strikes exhibit statistical regularities that can be and are utilized in economic decision making. In this, strikes resemble earthquakes, fires, floods, wars and other dramatic and costly occurrences.

The economic consequences of any of these classes of troubles, even earthquakes, can be influenced by concerned individuals. But an important differentiating characteristic among the classes is the degree to which their occurrence and/or severity can be affected by the action of individuals seeking to protect themselves. For example, although there is no known technique for preventing movement in the earth's surface in the vicinity of a geological fault, the economic effects of such movements can be avoided or reduced by locating structures away from known faults; by building costly earthquake resistance features into such structures as must be located near faults; by monitoring seismic signals adjacent to faults, etc.

Without attempting a systematic ranking of categories of troubles by the ease with which they can be avoided, it is our view that strikes rank at or near the top in ease of avoidability. It has often happened that cockpits of labor turmoil have been converted into situations of peaceful collective bargaining within a few years, by the joint efforts of unions and managements finally persuaded that the expected reward of victory was not worth the expected cost of struggle. While this observation is not novel, its implications have rarely been explored to the detriment of public policy making.

Limiting the cost of strikes, and other troubles, may be done either by individuals or by society (i.e., government). The action entailed may be either preventive or indemnifying (e.g., insurance). Thus methods of limiting strike cost present a double dichotomy: preventice methods, individual (private) and governmental; and indemnifying methods, private and governmental.

(a) Insurance

(i) Private

First, a few remarks about private Strike Insurance: occasionally, in the U.S., explicit insurance against strike losses has been purchased (by employers) though it is not commonly done. Apparently such (commercial) insurance had been brought by the baseball owners in anticipation, of a strike during the 1979 season and it was purchased in anticipation of the 1981 strikes.[1] Other instances where employers have insured against the cost of strikes can be found in California agriculture; Hawaiian sugar planting; newspaper publishing (nationwide); rubber manufacturing; railroad transportation and, most famous, airline transportation.[2] While the history of attempts to institute commercial insurance against strikes go back to the early years of this century, and continue to the present, most known instances are intra-industry loss sharing arrangements, possibly supplemented by "excess loss" rinsurance through a commercial carrier.[3]

Thus it is possible for employers to insure against the hazard of strikes and the possibility is occasionally realized. Nevertheless, it would not be seriously argued that employer purchases of strike insurance has greatly influenced the course of collective bargaining.

For workers, the situation is somewhat different: an important function of unions is to serve as mutual insurance organizations conveying help from non-striking workers to those on strike. Among members of the same union, provision of such assistance is a matter of course and of union law. In addition, it is common practice for one union to extend financial assistance to another in the event of a large strike. While pre-strike pledges of assistance by one union to another are not unknown, the more frequent arrangement is an informal understanding that (limited) assistance will be furnished as needed. Employer associations have also served as conduits of financial assistance during the course of a strike, but such manifestations of solidarity are less common among employers, or at least less well known, than among unions.

It is no part of our purpose to suggest that there is either too little, or too much, voluntary insurance against strike losses by participants in the collective bargaining process. But regardless of one's views on the desirability of encouraging such voluntary insurance, it cannot be successfully argued that private voluntary insurance against strike losses discourages strike activity. Considerations of moral hazard point to precisely the opposite conclusion: i.e., to the extent that a bargainer can shift the costs of greater intransigeance to others, his incentive to find a peaceful (i.e., non-strike) resolution of a dispute is lessened. This is one of the most important reasons for the reluctance of both employers and unions to make explicit promises of assistance to allies without obtaining some control over the bargaining conduct of the potential recipient.[4]

(ii) Social

Similarly, social or governmental insurance against strike losses is likely to encourage strikes by dispersing the private costs of disputants among many (non-involved) parties. That is, where strikers are given of Public Assistance (in one form or another) while a strike is in progress, or where employers are permitted to reduce tax payments as a (direct or indirect) consequence of strike caused losses of profits, the incentive to avoid strikes is reduced. The a priori plausibility of this argument is obvious. But empirical evidence is scanty: by far the best empirical work bearing on the subject is John Kennan's comparative analysis of the record of strike durations in New York and Rhode Island, the only two states where strikers are eligible for unemployment benefits, with that in other states.[5] Kennan found that the availability of unemployment compensation for strikers increased the expected duration of strikes consistent with the view expressed in the text. Assertions (and denials) of the effect of strike insurance (however provided) on strike activity are scattered throughout the literature, but apart from Kennan there has been virtually no serious attempt to argue the matter.[6] But however one appraises the effect of strike insurance on strike activity, it is clear that in neither the U.S., nor Canada has there been any serious attempt to increase the extent to which strike insurance is provided by the public sector to either party.

(iii) Costs and Benefits of Strike Insurance

The cost of insuring against loss from strikes is high, as compared with the cost of insuring against natural disasters, because of the greater moral hazard. That is, fear of injury or death greatly limits the risk that insurance will reduce sensitivity to the hazards of floods and earthquakes, but no analogous factor operates in the context of strikes.

On the side of benefits the contrast (as between natural disasters and strikes) is, also marked. In the case of natural disasters, moral hazard is slight; once an individual's location is set, there is virtually nothing he can or would want to do to increase the probability of being victimized by an earthquake. Thus the benefits of risk spreading are not dissipated by more negligent behavior that increases the probability of the hazard being realized. And, where the event insured against involves great loss but with low probability of occurrence (e.g., a natural disaster), the benefits of actually fair insurance are considerable.

On the other hand, the benefits of strike insurance are very limited. A collective bargainer who desires to avert the risk of striking, or being struck, can always accomplish his purpose by accepting the contract offered. While this course of action may involve some loss of expected income, the loss is not likely to be a large fraction of annual income for either party. Thus the primary utility of insurance, protection against potentially large losses which have a low probability of materializing, is largely absent in the case of strikes. These considerations (with respect both to costs and to benefits) explain why bargainers, those most directly affected by strikes, do not use the political process to demand that the government provide more strike insurance than they choose to obtain through voluntary activity.

Now let us consider "third parties;" i.e., those not directly engaged in collective bargaining and striking. In manufacturing, our focus is upon customers whose concern with avoiding strikes stems from a general concern with avoidance of delivery delay, whatever its source. These customers, normally business firms or other organizations rather than households, tend to self-protect rather than insure. They do this by arranging for multiple alternative sources of supply, and/or by making continued patronage conditional upon a good delivery record by the supplier. This is normal commercial practice: the fact that commercial insurance, or bonding, is rarely utilized as a supplement to the protective procedures mentioned, (despite the sophistication of the parties) suggests that only rarely would such practices be worth what they would cost.

In Retail Trade, Transportation, Public Utilities and various public sector services very often customers are individuals or households who encounter higher costs and possess less skill than organizations (because of lack of specialization) in using market instrumentalities such as insurance to limit risk. Nevertheless, interruption of "essential" services sometimes causes these households substantial inconvenience.

Unfortunately, however provided, insurance would be an inefficient means of protecting households against loss of expected utility on account of "interruption of service" caused by strikes or otherwise. This is primarily because measuring the loss to each claimant from (say) a public transportation strike would be extremely difficult and costly. The point becomes obvious as soon as we contrast the situation of the victims of a public transportation strike with that of victims of floods or an earthquake; the losses from a natural disaster are far more easily measured, and far larger per capita, than those from strikes. These differences are the primary reason why insurance is more appropriate, and more widely used, in indemnifying victims of natural disasters than those injured by strikes. In short, if potential victims of strikes are to be afforded greater protection, it must come from reducing the hazard rather than from ex post facto compensation.

Obviously, to reduce strike activity below the level that bargainers generate voluntarily, requires some form of government intervention in the bargaining process (including changes in the legal framework). But to say the least, such intervention would require political debate. One of the first questions of such a debate would seek to resolve is "how much loss to its victims does a strike involve?" Our research is directed toward providing an answer to this first question.

(b) Strike Prevention

Of their own volition, collective bargainers take considerable pains to limit the scale and frequency of strikes. They do this by jointly searching for ways of reaching contracts without undergoing strikes. We assume that the extent of this joint search is determined by balancing the gain from further diminution of strike activity against the cost of enduring greater restraints on their individual efforts to obtain more favorable contract terms. It is to be noted that the bargaining procedures agreed upon normally involve the possible occurrence of strikes.

The idea that efficient bargaining procedures may involve (occasional) strikes rests upon two assumptions: (i) efficiency (in bargaining) increases with experience in bargaining with a particular partner,[7] and (ii) novel issues arise with sufficient frequency to make it inefficient for (most) bargaining pairs to eliminate the possibility of strikes altogether.

Let us comment briefly on each of these assumptions: (i) (almost) any negotiation is a member of a sequence of negotiations in which the parties learn about one another's "bargaining style," and develop conventions governing bargaining behavior in specified states of the world--what we term "bargaining protocols."[8] Protocols guide bargainers to conventional solutions, conditional on the state of the world prevailing at the time of the negotiation, and thereby facilitate the reaching of contracts without strikes. Examples of provisions of bargaining protocols are: tacit or explicit agreements (i) to imitate movements in the wage levels for particular jobs governed by some other collective agreement to which the parties are not signatory; (ii) to follow a specified procedure (e.g., arbitration) in the event of an impasse in negotiations; (iii) to agree to negotiate wage rates during the life of an agreement in the event of a substantial movement in the cost of living.

Not all protocols are developed, de novo, by the bargaining pairs who adopt them. Most protocols are imitations of those followed by other pairs in the same industry and/or area, and are "learned" almost immediately upon the inception of a bargaining relation, often without an initial learning period during which strikes might have a high probability. However, some bargaining pairs choose to develop idiosyncratic protocols, and to learn by doing. The price of such first hand learning is more frequent bargaining impasses, and consequent strikes, than will be encountered by more experienced (or more imitative) bargainers.[9]

(ii) Where the circumstances surrounding the negotiation of a series of contracts can be described as "stable," bargaining protocols are increasingly more efficient and strike activity correlatively lower, with the passage of time. To a degree, this seems to happen--at least in the U.S.[10] That is, although some bargainers undergo an initial period of relatively high strike activity (at least for some bargainers), most bargaining pairs seem to develop a protocol that leaves strike activity at a roughly trendless level which is lower than that typically attained by inexperienced bargainers. However it is to be emphasized that the expected level of strike activity among mature bargainers does not reach zero; i.e., mature bargainers experience occasional strikes and expect them. We have found that the level of strike activity varies inversely with the cost of strikes across bargaining pairs, and conjecture that it increases with the difficulty of anticipating and resolving issues that cause disputes, and embedding such resolutions in a protocol.

That steady state levels of strike activity in a long-term bargaining relation are typically non-zero is due primarily to (a) the changing nature of the bargaining environment that keeps generating new issues for settlement at successive negotiations and (b) the finite horizon over which any protocol is operative. The emergence of new issues (and turnover of bargaining parties) compels revisions of protocols which present occasions for further learning. Because bargainers realize that, eventually, changing circumstances will make any agreement obsolete they limit the effort (investment) they will make to resolve in advance potential issues for dispute. Thus issues that have a low probability of arising, and are attended with great difficulty in settling, may--deliberately--be left unresolved. Although bargainers may perceive, ab initio, that such issues might arise, they rationally avoid a serious attempt at resolving them until "necessary." (I.e., the expected cost of resolving a particular potential issue, in advance of its arising, may exceed the expected benefit from having the issue resolved.) Consequently, when such issues do arise they must be settled without benefit of protocol, and with the attendant risk of a strike.

In short we assume that, at any time, the expected level of strikes for any bargaining pair could be reduced by greater effort to construct or extend a protocol, and that the extent of such effort is determined by balancing its marginal cost against the expected marginal benefit to the parties. The marginal benefit of effort to improve a protocol is the (imputed) reduction in expected strike cost; the marginal cost of such effort is not directly observable, but is assumed to vary across bargaining pairs independent of marginal benefit at any given level of protocol investment. Strike activity is assumed to vary across bargaining pairs, inversely with the effort both parties invest in designing the bargaining protocol, and directly with the inherent difficulties of anticipating and resolving bargaining issues.

To recapitulate: collective bargaining pairs invest in protocol creation to the point where the marginal gain from reducing strike activity equals the marginal cost of achieving such reduction. Third party costs aside, this implies that each bargaining pair will provide the quantity of self-protection against loss from strike activity that makes the marginal benefit of such protection equal to the marginal cost of providing it.

Ability to reach a low cost protocol, i.e., one associated with little or no strike activity, confers a cost advantage which is conducive to survival in a competitive product market. Thus existing bargaining pairs are predominantly those who have found efficient bargaining protocols. But efficiency is "private" efficiency; its gains are confined to the bargaining parties. Strike losses to third parties do not influence the structure of protocols.

Efficiency, however, is defined relative to a particular set of legal arrangements concerning allocation of the strike costs. If, for example, the parties to an otherwise lawful strike were liable for damages to third parties injured by interruptions to delivery, a privately efficient protocol might well entail less strike activity than occurs under present legal arrangements.

While an investigation of the differences in expected strike costs to society under alternative legal arrangements might be of great value, we have here attempted only a first step; i.e., estimation of the loss of output from a unit of strike activity. While the costs of strikes to third parties may in fact have lead, indirectly, to payoffs to the bargainers for reducing strike activity, we have not yet been able to investigate the implications of this conjecture for Canada.[11]

II. Measuring Strike Cost

(a) Concepts

The cost of a strike is primarily the value of the net output sacrificed by its occurrence. The loss of net output caused by a strike differs from the gross because of two types of offset: (1) the labor time of strikers may be made available for production elsewhere, and the reduction in output may lessen wear and tear on plant and equipment, and (2) there may be additional production before and after a strike to offset the output lost while it was in progress. We discuss these types of offsets seriatim:

(1) Manifestly, strikers may find alternative jobs and/or engage in household production, while plant and equipment may be refurbished during a strike. However, these offsets to loss of gross output may themselves be (partially) offset by intertemporal substitution of activity, so that their magnitudes would be hard to estimate.[12] In any case, while acknowledging their existence, we abstract from these offsets to strike cost and conjecture that they are quantitatively unimportant.

(2) Where the product is storable, an interruption to a firm's output stream may be offset by producing and delivering in advance of an anticipated strike and/or by its customers depleting their (own) inventories during the strike and rebuilding them after its termination. To the extent that either of these adjustments occurs, the loss of output during a strike is (partially) offset though there may be a cost in inconvenience and extra expenditure resulting from distortion of the time shape of the output stream. While not asserting that the cost of such distortion is trivial, in this initial attempt at measuring strike cost we neglect it and treat the cost of a strike as loss of net output defined as the sum of the reduction in (undiscounted) outputs summed over an appropriate time period.

To estimate the "cost of an average strike" in a given manufacturing industry, we constructed a two equation model that describes the monthly levels of output and strike activity. A detailed description of the model is presented in the Appendix, but its salient features are as follows: output and strike activity are represented as a bivariate autoregressive process with a maximum lag of 24 months. The effects of seasonality and trend are removed by regression on seasonal dummies and a linear trend.

In any given month, output is assumed to be (i) white noise plus (ii) the effect of strike activity in that month (the contemporaneous effect) plus (iii) the lagged effect of strike activity in previous months plus (iv) the effect of anticipated strike activity. Anticipated strike activity is not directly observable and is calculated from the history of recorded strike activity. Thus, though they are conceptually distinct, the effects of (iii) and (iv) are amalgamated in the estimation process with the result that their combined impact on output is reflected in the coefficients of current output on lagged strike activity.

The cost of strike activity is estimated as the sum of (ii), and (iii). Our conjecture is that the sign of (ii) is negative, the sign of (iii) positive and of (ii) + (iii) negative; i.e., the net or total effect of a strike is to reduce output although the loss during the strike is partially offset by movements of output "before" and "after."

(b) Measurements of Strike Activity in U.S. and Canadian Manufacturing.

(i) Scale of Strike Activity

Before comparing the cost of strikes in U.S. and Canadian manufacturing industries, let us first compare the dimensions of strike activity in the two countries. To do this we introduce Table 1, columns 3 and 6 of which give the mean duration of strikes for each of the 18 three digit manufacturing industries in Canada and the United States for which precise matches of coverage can be established. (For the U.S., the sample period was 1953-76, and for Canada, 1960-76.) In 10 of these 18 industries, the mean strike duration in Canada was greater. Weighting each industry by its mean number of strikes per year, we find an average strike duration of 30.5 days in U.S. manufacturing and 30.1 days in Canada, i.e., the average strike durations were virtually identical in the two countries.

However, the median length of strike durations in U.S. manufacturing industries was somewhat greater than in Canadian manufacturing, 31.2 days to 29.3. This suggests that the distribution of strike durations was more (positively) skewed in Canada than in the U.S., and this is indeed the case. As can be seen from Appendix Table 2, in six of the 43 Canadian industries studied, mean strike duration exceeded 40 days, the highest being 68 days (Paper Boxes and Bags), while in the U.S. only one of the 63 industries studied had a mean strike duration of more than 40 days (Wooden Containers with 46.2 days).

Table 1

Summary of Strike Statistics for U.S. and Canada for 18 Comparable Industries

Industry Name	U.S. (1) Number of Strikes Per Year	U.S. (2) Number of Strikers Per Strike	U.S. (3) Mean Duration of Strikes in Days	Canada (4) Number of Strikes Per Year	Canada (5) Number of Strikers Per Strike	Canada (6) Mean Duration of Strikes in Days
Glass Containers	15.8	1190.9	20.7	6.8	446.4	28.7
Blast Furnaces & Steel Mills	90.1	524.2	24.9	12.5	825.0	18.8
Iron & Steel Foundries	100.7	327.5	33.1	9.5	182.2	38.1
Other Primary Metal Prod.	170.4	387.0	32.6	12.9	195.7	43.0
Cutlery, Handtools & Hardware	40.5	268.9	29.6	9.8	111.3	39.3
Farm Machinery & Equip.	40.0	725.9	37.5	4.4	846.8	18.8
Office & Store Machinery	12.1	719.3	33.0	2.4	175.4	22.4
Electrical Industrial Apparatus	49.5	400.0	31.8	14.2	232.3	46.6
Household Appliances	34.8	1026.1	28.4	6.9	476.0	29.0
Radio & TV	10.0	425.1	23.6	1.2	418.0	12.4
Communications Equip.	27.0	1054.5	31.2	5.9	1100.8	16.9
Other Electrical Components	69.6	331.4	28.4	6.3	163.3	36.3
Shipbuilding, Military Tanks & Other Transportation Equipment	63.5	730.4	32.1	7.7	761.1	16.9
Scientific & Engineering Instruments	44.6	305.3	35.1	2.6	239.9	26.6
Pulp & Paperboard Mills, Except Building	52.3	466.8	29.6	40.9	622.8	31.2

Table 1

Summary of Strike Statistics for U.S. and Canada for 18 Comparable Industries

Industry Name	U.S. (1) Number of Strikes Per Year	U.S. (2) Number of Strikers Per Strike	U.S. (3) Mean Duration of Strikes in Days	Canada (4) Number of Striker Per Year	Canada (5) Number of Strikers Per Strike	Canada (6) Mean Duration of Strikes in Days
Paperboard Containers	55.2	163.2	31.2	10.9	175.5	49.9
Die-Cut Paper & Board & Other Paper Products	43.7	181.5	28.4	10.1	90.0	68.4
Other Petroleum Products	24.0	865.3	44.8	4.6	232.6	35.4

Source: Appendix Table 2

Now let us turn to column 1 (of Table 1), which gives the number of strikes per year and column 2, the mean number of workers per strike. In number of strikes per year the U.S. clearly exceeds Canada: in each of the 18 industries listed, the number of strikes per year was greater in the U.S. Among the Table 1 industries, the ratio of number of strikes per year in the U.S. to the number in Canada, ranged from 1.28 to 17.15, with a median of 5.22. Among all manufacturing industries studied, the median number of strikes per year was 41.9 in the U.S. and 6.2 in Canada.

However, in number of strikers per strike, the result is quite different. In ten of the eighteen industries in Table 1, the number of workers per strike was greater in Canada. Among these eighteen industries, the median number of strikers per strike was 446.1 in the U.S. and 235.8 for Canada; the U.S. mean was 566 while the corresponding Canadian mean was 405. The greater difference between mean and median in Canada suggests greater skewness across Canadian industries in size of strikes.

This impression is confirmed when we compare the figures number of strikers per strikes for all U.S. and all Canadian manufacturing industries covered in this study. For the U.S., the mean by industry of strikers per strike was 199, and for Canada, 219. The output weighted means of strikers per strike is 174 for the U.S. and 202 for Canada.[13] That the weighted means, in both countries, are less than the unweighted implies that, across industries, there is a negative correlation of strike frequency (number of strikes per month) with size of strikes (number of strikers per strike). The inverse correlation of size with frequency of strikes is in keeping with our general view that bargainers attempt to minimize the cost of contract negotiation (including cost of strikes) over time, by trading off various dimensions of such activity. However, for comparative purposes, the main point is that (mean) size of strike is greater in Canada. This goes counter to any simple story of scale differences in the two economies being responsible for differences in strike activity.

A major difference between the countries in size of strikes lies in their respective coefficients of variation across industries: .928 for the U.S. and 1.304 for Canada. To explain this difference, consider what determines the mean size of strikes in an industry: the mean size of strikes in an industry varies with the extent to which its contract negotiations are "coordinated." Coordination varies from the extreme of "complete" (where all workers employed in an industry strike if any of them strike), to "nil" where no more than a small fraction of an industry's work force ever strikes at any one time.

Coordination of an industry's contract negotiations probably increases with "centralization of bargaining," and/or with the concentration ratio of workers among (a few large) bargaining units. However, coordination and centralization are not the same; for example, it is possible for an industry to have many bargaining units, but with a strong "pattern effect" so that once a key bargain is struck all other bargaining pairs settle on more or less the same terms as in the key bargain. Negotiation over a key bargain may cause a relatively small strike involving only the bargainers; or it may generate a substantial strike involving coalitions of firms (and their employees) or even the entire industry.

The relation of bargaining structure and the size of strikes, in both countries, is a matter greatly in need of research. But for the present we assume that across industries, in both countries, greater size of strikes is associated with greater coordination of bargaining within an industry. Accordingly, we surmise that within industries, in Canadian manufacturing,

Table 2

Measures of Strike Cost in 18 Manufacturing Industries for Which Cross-Country Matches Can Be Made

	U.S.		Canada	
Industry Name	Cost per Strike in 000's of 1972 Dollars (1)	Cost of Strikes as a Percentage of Annual Output (2)	Cost per Strike in 000's in 1972 Dollars (3)	Cost of Strikes as a Percentage of Annual Output (4)
Glass Containers	7.8	.0001	-38.9	-.0012
Blast Furnaces & Steel Mills	1699.6	.0067	27.2	.0004
Iron & Steel Foundries	274.2	.0049	19.7	.0008
Other Primary Metal Products	-85.4	-.0007	-27.2	-.0010
Cutlery, Handtools & Hardware	60.8	.0017	2.4	.0001
Farm Machinery & Equipment	-54.6	-.0004	-25.8	-.0005
Office and Store Machinery	-220.7	-.0004	-4.6	-.0001
Electrical Industrial Apparatus	-310.4	-.0030	15.3	.0003
Household Appliances	148.9	.0010	74.0	-.0015
Radio & TV	1,238.0	.0041	21.8	.0003
Communication Equipment	-88.0	-.0002	-85.8	-.0009

Table 2

Measures of Strike Cost in Manufacturing Industries In Which Cross-Country Matches Can Be Made

Industry Name	U.S. Cost per Strike in 000's of 1972 Dollars (1)	U.S. Cost of Strikes as a Percentage of Annual Output (2)	Canada Cost per Strike in 000's in 1972 Dollars (3)	Canada Cost of Strikes as a Percentage of Annual Output (4)
Other Electrical Components	200.7	.0019	100.9	.0017
Scientific & Engineering Instruments	-54.6	-.0006	-32.8	-.0013
Shipbuilding, Military Tanks & Other Transportation	1,193.7	.0062	-80.8	-.0007
Pulp & Paperboard Mills	805.6	.0041	229.6	.0035
Paperboard Containers	189.2	.0015	14.4	.0002
Die-Cut Paper & Board & Other Paper Products	74.7	.0005	94.9	.0013
Other Petroleum Products	-4,415.9	-.0023		.0008
Unweighted Mean	327.3	.0018	52.7	.0005

Table 3

Correlation Coefficients of Industry Levels of Strike Cost and Strike Activity: U.S. and Canada

(Correlation Coefficients are Zero-Order)

	Cost Per Strike		Strike Cost Per Year	
	U.S.	Canada	U.S.	Canada
Mean Duration	.245	-.073	.149	-.046
Number of Strikes per Year	.057	-.052	.021	-.608

collective bargaining is more coordinated, implying less frequent but larger strikes than occur in the U.S.

(ii) Cost of Strikes

Table 2 presents estimates of the cost of strike activity, by industry, for each country. The figures in column 1 present the figures on cost per strike.[14] In seven of the eight industries where (a) a cross-country match is feasible and (b) where strike cost is measured as positive, cost per strike was greater in the U.S. In these seven industries, the mean of the ratios of U.S. cost per strike to Canadian cost per strike (in the same industry) was 25.29 to 1; in the sole industry where cost per strike was greater in Canada, the ratio of Canadian to U.S. cost was 1.27 to 1. Among all industries where cost per strike was positive, the (unweighted) mean cost per strike in the U.S. was $389,000 and in Canada, $87,000; i.e., the U.S. mean was 4.47 times the Canadian. Mean cost per strike for all industries studied was $152,500 for the U.S. and $26,900 for Canada. In the 18 comparable industries, U.S. cost per strike was $327,300 and Canada's $52,700.[15]

The markedly greater dollar cost per strike in U.S. industries might possibly be explained as an artifact of difference in scale. But such an explanation would be very difficult to reconcile with the fact that as a percentage of annual output, strike costs were greater in the U.S.; the exception (Die-Cut Paper) is the one industry where cost per strike in Canada was greater than in the U.S. The unweighted mean of the ratios of these percentages (i.e., the mean of the ratios of the U.S. entry in column 2 to the Canadian entry in column 4 of Table 2) was 9.05 to 1. The (unweighted) mean of the percentages of strike cost divided by annual output in all U.S. industries where strike cost is positive is .0021 (two tenths of one percent);

the corresponding figure for Canada is .00096 (less than one tenth of one percent).

Thus, overall, the mean of the percentage losses of industry output due to strikes in Canadian manufacturing was a little less than half that in the U.S. When the comparison is restricted to "matched" industries, the average of the percentage losses of output in Canadian manufacturing was about one ninth that in the U.S. In nuce, the greater cost per strike in U.S. manufacturing was not a mere scale phenomenon, but reflective of bargaining procedures that also led to loss of a larger percentage of potential output (on account of strike activity) than occurred in Canada.

That cost per strike in the U.S. tended to be greater than in Canada is quite surprising when we remember (pp.) that number of workers per strike was larger in Canada, while mean durations of strikes were roughly equal. The simplest and indeed the only explanation we can offer for this anomaly is that, in Canada, there was greater facility of intertemporally substituted output. That is, although Canadian strikes were appreciably bigger and not noticeably shorter, than those in the U.S., they involved smaller losses of output because more of the output lost during the strike was made up during the pre and post strike adjustment periods.

This rationalization of comparative cost per strike immediately suggests an explanation of the fact that in the U.S. strikes cost a larger percentage of manufacturing output than in Canada. Output losses from smaller but more frequent strikes, characteristic of the U.S., are not so effectively offset by intertemporal substitution, as those from the larger and less common strikes of Canada. Why this should be so is, at this stage, necessarily a matter for conjecture.

Although there are intercountry differences in the cost of strikes, by any reasonable measure these costs are low in both countries. For the U.S. the loss of annual output in the "average" industry was 9/100 of one percent (.0009 per cent) of average annual output; this was over five times the analogous figure for Canada (.00017).[16] For the 18 comparable industries in Table 2, the mean percentage loss of annual output was .00181 in the U.S. and in Canada, .00050.[17]

(iii) Interpretation of Strike Cost Measurements

Whether measured in dollar terms or as a percentage of annual output sacrificed, in both U.S. and Canadian manufacturing, per annum cost of strike activity is small. But confidence in this conclusion is necessarily undermined by the fact that in 20 (of 63) U.S. manufacturing industries, and in 18 (of 43) Canadian, cost per strike as measured, was negative. As explained above (pp.) and in the Appendix (pp.), such measurements are false, a priori, and we interpret them as reflective of errors and assume the true measurements to be indistinguishable from zero.

It is doubtful that, in any industry, average cost per strike is truly zero. What our interpretation means is that the errors of measurement and aggregation are sufficiently large relative to the (presumptively positive) true cost per strike as to cause the measured effect to appear negative in a substantial number of industries in both countries. For purposes of policy making, this means that no decisions should rest upon the estimated size of cost per strike in these industries.

(iv) Inter-Country Differences in Cross-Industry Patterns of Strike Cost

Our measurement of strike cost, both per year and per strike, is a new type of measure and its covariation across industries with conventional measures of strike activity, in both countries, is of some interest. These "conventional" measures are number of strikes per year (strike frequency) and mean duration of strikes (duration). As the correlation coefficients reported in Table 3 show, in Canada, cost per man day of strike (strike cost) varies inversely with each of these measures, though neither relationship is precise. In the U.S. the signs of both these relations are reversed though, once again, the relations are imprecise.[18]

The pattern of signs and sizes of the coefficients reported in Table was quite unexpected and is therefore of some interest.

Strike Frequency

In Canada, cost of strikes per month (monthly strike cost) decline with strike frequency, the correlation coefficient being significant at the one percent level. The sign of this relationship implies that, in Canada, industries with more frequent strikes lose less output (per month) than those with less frequent strikes. That is, across industries, the marginal impact of strikes on monthly output is more than offset by the associated increase in facility with which production can be substituted through time. In other words, across Canadian manufacturing industries, bargaining institutions associated with more frequent strikes are also associated with sufficiently smaller losses of output per strike as to induce an inverse relation between strike frequency and output losses (on account of strike) per period of time, as well.

But this relationship does not obtain across U.S. manufacturing industries: the correlation is positive, though insignificant at any conventional level. Our proposed explanation of this intercountry difference is as follows: in Canada, cross-industry differences in strike frequency reflect mainly differences in strike frequency per bargaining unit while in the U.S. these differences are greatly influenced by differences in number of bargaining units per industry as well. We conjecture (i) that more bargaining units per industry imply more "strike opportunities" per industry (per time period) and therefore a higher strike frequency per period and (ii) that there are more bargaining units per industry in the U.S. We conjecture further (iii) that there is no particular direction of association of number of bargaining units per industry and cost per strike so that cross industry differences in both strike frequency and strike cost per month (cost per strike times number of strikes per month) are at most only weakly related.

We suggest that because of (iv) the negative cross industry relation between strike frequency and cost per strike found in Canada. Of course, this rationalization is tentative and is in need of further investigation.

Strike Duration

In the U.S. there is a positive correlation of cost per strike with mean strike duration that is significant at the five percent level, but in Canada no such relationship obtains. (Monthly strike cost is not significantly related to strike duration in either country.) The obvious interpretation of the U.S. result is that intertemporal substitution of production becomes more difficult as strikes grow longer. Why this statement does not apply to Canada, as well, is not clear, and we leave it as a point for further research.

III. Conclusions

(1) Whether strike cost is measured per strike, per annum or as a percentage of annual output, it is "small" in both U.S. and Canadian manufacturing. N.B. The reader is reminded that our analysis refers only to strike costs born by the bargainers themselves, and does not take into account "third party" losses.

(2) Both cost per strike and (annual) strike cost as a percentage of annual output were generally greater in the U.S.

(3) Number of strikes per annum was much greater in the U.S., but number of strikers per strike was greater in Canada. Strike durations in the two countries were about the same.

In view of the methodological problems and novelty of our approach, policy inferences should be drawn cautiously. (1) would suggest that so far as manufacturing industries are concerned, the potential gains to the bargainers from reducing strike activity below observed levels would be slight. (2) implies that, at least during the period analyzed, i.e., through 1976, there was little reason to believe that in manufacturing industries the U.S. collective bargaining institutions were more efficient in avoiding strike cost than Canadians.

(3) suggests a reconciliation of (2) with the common impression that Canada is more "strike prone" than the U.S. Canadian strikes are larger, but are less costly than those in the U.S. The implication is that ease of intertemporal substitution of output is greater, and strike cost accordingly lower, in Canada.

FOOTNOTES

[1] See The Sporting News, April 19, 1980, page 7. I am indebted for this reference to an unpublished paper by L.M. DeBrock and A.E. Roth, "Strike Two: Labor-Management Negotiations in Major League Baseball," University of Illinois, June 1980.

[2] A good survey of the history of employers use of strike insurance is Harold Foster "Employers' Strike Insurance," Labor History, Fall, 1971, vol. 12, no. 4, pp. 483-529. For a detailed discussion of strike insurance in the airline industry see S.H. Unterberger and E.C. Koziara "Airline Strike Insurance: A Study in Escalation," Industrial and Labor Relations Review (ILRR), vol. 29, no. 1, October 1975, pp. 26-45 and a subsequent exchange between the authors and H.R. Northrup in ILRR, April 1977, vol. 30, no. 3, pp. 364-379. These articles contain further references.

[3] The articles cited in notes 1 and 2 indicate that both employers and carriers are reluctant to discuss details of strike insurance or of loss pooling arrangements in the event of strikes.

[4] For example, under the airlines Mutual Assistance Pact (MAP), some lines were consistent gainers while others were consistent losers. M.L. Kahn, ("Airlines," Chapter 7 of "Collective Bargaining: Contemporary American Experience," edited by G.G. Somers, Industrial Relations Research Association, Madison, Wisconsin, 1979, especially p. 356) attributes the payment, in 1978, to Northwest Airlines of $105 million because of a 109 day shutdown as a contributing factor to the subsequent demise of MAP.

[5] J.T. Kennan, "The Effect of Unemployment Insurance Payments on Strike Duration," in Unemployment Compensation: Studies and Research, vol. 2, National Commission on Unemployment Compensation, July 1980.

[6] For evidence concerning the relation of public sector financial support for strikers and the volume of strike activity in the United Kingdom, see John Gennard "Financing Strikers," Halstead Press, John Wiley, New York, 1977, especially Chapter 7 and the references there cited. Gennard's reading of the evidence supplies only ambiguous support for the assertion in the text. The references in n. 2 contain both assertions and denials of the effect of strike insurance on strike activity, but little evidence to support either view.

[7] Experience in bargaining is to some extent trasferable from one "partner" to another, but knowledge of the idiosyncracies of a particular partner is always valuable, whatever one's intent.

[8] M.W. Reder and G.R. Neumann, "Conflict and Contract: The Case of Strikes," Journal of Political Economy, October 1980, pp.

[9] Of course, not all bargainers are capable of working out a protocol. But since an efficient protocol--one that economizes on strike activity--lowers unit cost of production in the long run, ability to achieve bargaining efficiency confers a competitive advantage. Therefore we assume that surviving pairs tend to be relatively efficient contract negotiators.

[10] Reder and Neumann, op. cit.

[11] We have been able to make some estimates of the effect strike costs on inter-industry wage rate differences in the United States which we interpret as reflecting payoffs of customers of the employer to the bargainers to limit interruptions to delivery from strikes. (Reder and Neumann "The Effect of Strike Cost on the Interindustry Wage Structure.")

[12] E.g., workers who earn less than normal during the strike will be more eager for overtime work--and pay--before and/or after the strike. Employers, the life of whose equipment is lengthened by a strike, may invest less subsequently, etc.

[13] The weighted means are calculated using industry output as the weighting factor.

[14] These costs are defined as output lost (in 1972 U.S. dollars) associated with strike activity as discussed in the text.

[15] These means refer to all industries, including those whose measured strike cost is negative. The corresponding means for those industries with strike costs measured as positive are: for the U.S., $353,600 and for Canada, $94,800.

[16] These numbers are the unweighted means of the industry percentage losses of output attributable to strike activity. The percentage loss of output due to strike activity, for a given industry, is calculated as follows: (1) the loss of output associated with a man-day of strike activity is calculated from the vector autoregression as described in the Appendix; (2) the result of (1) is multiplied by the number of man-days of strike per year and (3) the result of (2) is divided by mean output per year during the sample period.

As calculated, the denominator of (3) reflects realized output and not output as it would have been in the absence of strikes. While the spirit of our measurement procedure would suggest use of the latter measure, we have refrained from making the requisite adjustments for three reasons: (i) specifying the appropriate calculations would require a much more precise notion of the relation between non-strike output and anticipated strike activity than is presently available; (ii) the calculations would almost surely be tedious and costly and (iii) given the very small magnitude of measured strike effects, it is very unlikely that the implied adjustments would have substantially affected our results.

[17] The means in the text refer to all 18 of the comparable industries. The analogous means for only those industries having strike costs recorded as positive are: for the U.S. .00296, and for Canada, .00090.

[18] The correlation coefficients reported in Table 3 are zero order. Partial correlation coefficients are not reported because the only coefficient estimated is that of strike cost (output lost) on mandays of strike activity, the observations being individual industries in each country. Mandays of strike activity is identically equal to the product of the number of strikes of each given duration times the number of workers involved in each strike of given duration. Correlations of strike cost both with durations and frequency of strikes are calculated from this single regression and are not estimates of the slopes of a cross industry multivariate linear model relating strike cost to strike duration and to strike frequency.

APPENDIX

I. Strike Activity: Costs

Previous discussions of strike cost have focused almost exclusively upon the immediate losses of output and workers' earnings that are caused by cessation, partial or total, of production due to a strike. Implicit in these discussions is the view that what is lost today is lost forever; that is, output not produced and wages not earned during a strike will never be regained. While this may indeed be the case for some activities--for example, in a monopoly where the output cannot be stored--it is not the case in all. Ability to substitute production intertemporally through inventory accumulation and decumulation implies that to some extent the immediate "costs of a strike" are offset.

Let us now define the term, "strike costs." Consider the simple case of a nonstorable good produced by one firm only. If demand is intertemporally separable, the costs of a strike are the sum of the loss of quasi-rents by the firm, the loss in wages and producers' surplus by workers, and the loss in consumer surplus by consumers. This is consonant with the conventional view of strike costs; i.e., both participants lose and adverse third-party effects occur.

In the polar opposite case of a constant cost industry with many producers, a strike of some (but not all) firms causes loss to the parties involved in the form of (sacrificed) quasi-rents and wages, but no loss to consumers. This is because other producers increase output to offset reduced production by those engaged in striking, without generating any increase in total cost. That is, in this case, there is a private cost to strike activity, borne by the participants, but no social cost because the loss to the participants is offset by the gains of other producers, with industry output and customer welfare unchanged. The real world, of course, consists of cases intermediate to these extremes.

To facilitate exposition, let us first consider the (polar) case of a single producer, producing a storable commodity.

(i) Strike Cost to a Single Producer.

Except for the fluke case of an industry with constant supply price, intertemporal substitution of production operates both to offset partially the contemporaneous cost of a strike and to complicate the measurement of strike cost. Let us consider the effect of intertemporal substitution:

(a) Strike Cost as Output Loss.

If information on specific bargaining pairs were available, a stylized view of the effect of a strike could be depicted as in figure 1.

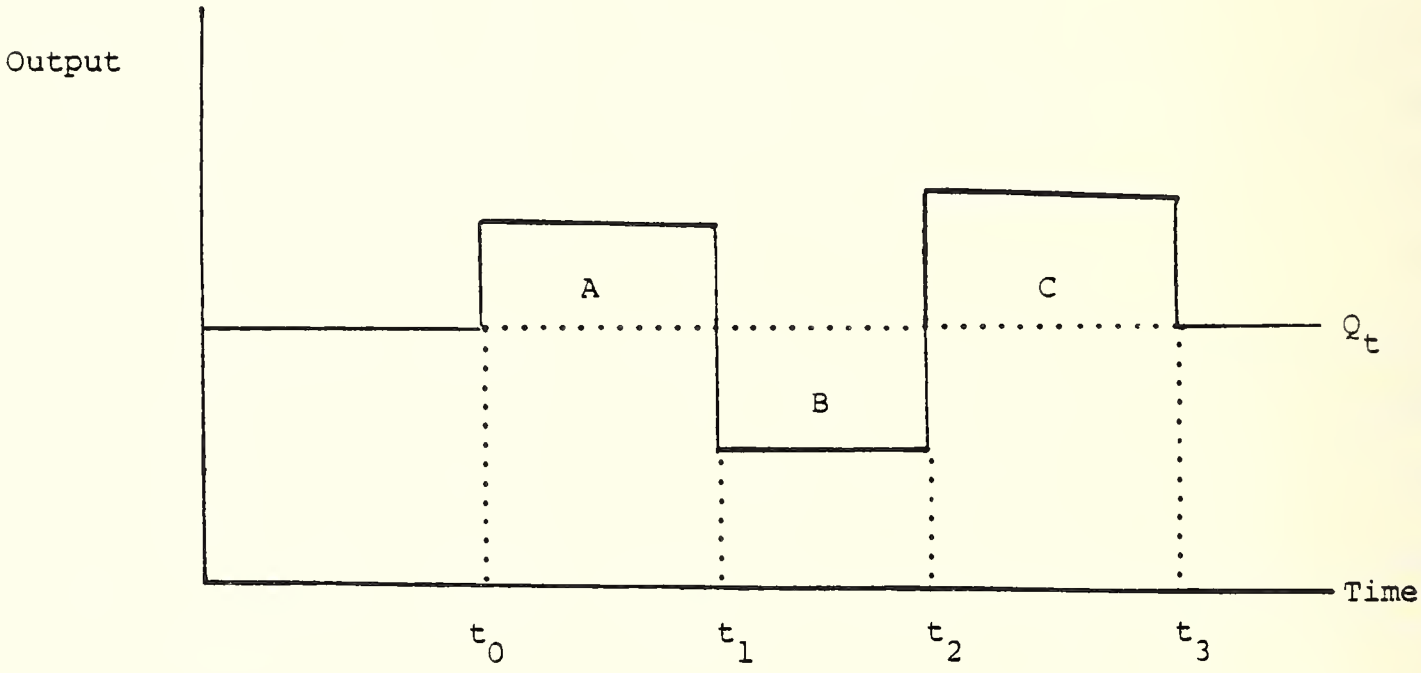

Figure 1

For a particular bargaining unit the optimal production path during a no strike period is given by Q_t. Assuming that strikes are (perfectly) anticipated, would lead the firm to deviate from Q_t by building up inventories in the pre-strike period $(t_1 - t_0)$, running them down during the strike period, $(t_2 - t_1)$, and rebuilding inventories to the post strike optimal level during the period $(t_3 - t_2)$. The net output lost due to a strike would be, apart from interest paid on inventory accumulation, $B - A - C$.[1]

In essence, B is the output lost while the strike is in progress and A + C is the pre and post strike "catch up" output to satisfy a level of demand for output that is assumed to be unchanged. To fix ideas consider the algebraic counterpart of Figure 1 presented in equation (1).

$$1) \quad Q_t = a_1 S^*_{t+1} + a_2 S^*_t + a_3 S_{t-1} + a_4 Q_{t-1} + \varepsilon_t$$

$$(2) \quad S_t = b_1 S_{t-1} + \eta_t \; ; \; \begin{pmatrix} \varepsilon_t \\ \eta_t \end{pmatrix} \sim N(0, \Sigma)$$

In (1) the quantity of current production that is planned for period t, as of period $t-1$, is affected by the expected number of strike days in the succeeding period, S^*_{t+1}; the expected number of current strikes, S^*_t, the actual number of strike days in the previous period, S_{t-1} and the entire past history of production represented by equation (1). (Expected values for future periods as of period $t-1$, are designated by the superscript, $*$.) To facilitate exposition, initially assume that strike activity follows the path of a simple first order autoregression.

The first term on the right hand side of (1) captures the effect of inventory buildup in anticipation of a future strike, while the third term, which reflects lagged strike activity, captures post-strike restocking. Similarly, one could interpret the effect of S^*_t on Q_t to be the anticipated effect (as of $t-1$) of strike activity in t on output in t, including the planned reaction conditional on a strike occurring in t. In terms of figure 1, we would expect a_1 and a_3 to be greater than zero, and a_2 to be less than zero.

Unfortunately, it is not feasible to estimate (1) because anticipations of strikes are not observable. To remedy this, it is necessary to relate expected strike activity to observable behavior. One such relationship that is frequently assumed is that expectations of behavior are formed "as if" they were determined by the structure of the process that generates actual behavior. That is, expectations are assumed to be rational in the sense of Muth [1961]. Specifically, S_t^* and S^*_{t+1} are determined by Ω_{t-1}, the information available at $t-1$; i.e., the history of Q and S as of $t-1$. Given these assumption about the determination of strike anticipations and the further assumption of independence among the disturbances of (1) and (2), expectations of strike activity as of $t-1$ satisfy:[2]

$$\text{a.)}\quad S^*_t = E(S_t \mid \Omega_{t-1}) = b_1 S_{t-1}$$

(3)

$$\text{b.)}\quad S^*_{t+1} = E(S_{t+1} \mid \Omega_{t-1}) = b_1^2 S_{t-1}$$

Inserting (3 a) and (3b) into (1) yields

$$(1')\quad Q_t = (a_1 b_1^2 + a_2 b_1 + a_3) S_{t-1} + a_4 Q_{t-1} + \varepsilon_t$$

which is a reduced form relationship combining the structural parameters of both the output and strike activity processes and of the expectations formation process.

Obviously, a different specification of (2), say a p^{th} order autoregressive structure, would introduce additional lagged values of strike activity into (1'). Still more complicated expressions would result if it were assumed that strike activity depended in part on expectations of future output, and/or on past output, as well as on the variables already in (2).[3] Allowing expectations of strikes to depend on lagged output and lagged strikes, and vice versa, yields the general model for expectation horizon of length T as (4).

$$(4) \quad Z_t = \sum_{L=0}^{T} C_i Z^*_{t+i} + B(L)Z_{t-1} + \mu_t,$$

where Z_t is the vector $\left\{ \begin{matrix} Q_t \\ S_t \end{matrix} \right\}$, and T is the number of future periods whose expectations affect current behavior. As Wallis (1980) has shown, the solution to (4) in terms of observed values of the variables (i.e., Z_{t-1}, Z_{t-2},...) requires (as inputs) forecasts of all future values of Z_t. But these forecasts are themselves functions of weighted sums of past realizations which are determined by still earlier forecasts, and so on. To take this into account, we must consider vector-autoregressive models of the form, (5) in which L is the lag operator, defined by $A(L) = 1 - A_1L - A_2L^2 \ldots A_pL^p$.

$$(5) \quad A(L)Z_t = \mu_t$$

For many purposes (e.g., estimating the relative amount of pre-strike inventory buildup in production), "unrestricted" models such as that presented in (5) are uninformative. But they are quite useful for the limited purpose of calculating the effect of strike activity on production without imposing arbitrary restrictions on either the order of the lag structure of the process, or on the horizon of the production planning process. An alternative way of writing (5) is the moving average representation given in (6).[4]

$$(6) \quad Z_t = A(L)^{-1}\mu_t = \sum_{L=0}^{-\infty} \psi_L \mu_L$$

In (6) the ψ_i are the impulse response matrices defined by the matrix long division implicit in the equation; this sequence of matrices traces out the movements in the state variables (Q_t, S_t) induced by the innovations, μ_t, μ_{t-1}, etc. Thus for a particular shock, say μ_t, the contemporaneous effect is $\psi_0\mu_t = I\mu_t = \mu_t$, and the effect of this shock in the next period is $\psi_1\mu_t$. The cumulative effect on the system of such a shock is given by

$$(7) \quad F = \sum_{L=0}^{\infty} \psi_L \mu_{t+L} = G\mu_t$$

where G is the 2×2 "steady state gain" matrix.[5] Thus F contains the sum of previous, current, and eventual responses to a particular shock; no further decomposition into, say, anticipated and unanticipated components can be made without imposing further restrictions on the model.

In section IV below we present estimates of the effect of strikes on output using on equations (5) and (7). But before discussing the estimates, some description of the data is necessary.

II. Data

Conceptually, the appropriate unit of analysis of strike activity is the bargaining unit, an entity which can be larger than an industry but which is (in the United States) very frequently smaller than a firm. Since relevant data organized by bargaining units are not available we are forced to utilize measurements referring to aggregates of bargaining units; per force, these measurements make the industry our unit of observation.

As explained in the preceding section, we measure the cost of a strike by the loss in output with which it is associated. Because strikes vary in length, and anticipations of strikes influence the time path of production before the start and after the termination of a strike, measurement of strike "caused" output loss requires analysis of the time path of production.

For the U.S. information relevant to the time path of production is available for 73 three-digit "industry groups" from the Manufacturer's Shipments, Inventories, and Orders, M3 series.[6] These industry groupings are based on four-digit SIC codes, and are available from 1958 to the present.

Data on strike activity are available from the Bureau of Labor Statistics Work Stoppages Historical File for the period 1953-1977. These data are classified by three-digit SIC code, rather than four-digit, which leads to "overlap" in some industries when compared with the output data. Aggregating those groups that overlap yields the sixty-four distinct industry groups described in Appendix Table 1.

Table 1

Industry Definitions: U.S.

	Industry Name	SIC Number
1.)	Wooden Containers	244
2.)	Wood Buildings & Mobile Homes	245
3.)	All Other Wood Products[a]	241-243, 249
4.)	Household Furniture	251
5.)	All Other Furniture	252-254, 256, 259
6.)	Glass Containers	322
7.)	Kitchen Articles & Pottery	326
8.)	Other Stone Clay & Glass[b]	321, 323-325, 327-329
9.)	Blast Furnaces & Steel Mills	331
10.)	Iron & Steel Foundries	332
11.)	Other Primary Metal Products	333-339
12.)	Metal Cans, Barrels, & Drums	341
13.)	Cutlery, Handtools & Hardware	342
14.)	Building Materials & Wire Products	343, 344
15.)	Ordinance & Accessories	348
16.)	Other Fabricated Metal Products[c]	345-347, 349
17.)	Steam Engines, Turbines & Internal Combustion Engines	351
18.)	Farm Machinery & Equipment	352
19.)	Construction, Mining & Material Handling Equipment	353
20.)	Metalworking Machinery, Miscellaneous Equipment & General Industry Machinery	354, 356
21.)	Machine Shops	359
22.)	Special Industry Machinery	355

Table 1

Industry Definitions: U.S.

	Industry Name	SIC Number
23.)	Office & Store Machines	357
24.)	Service Industry Machines	358
25.)	Electrical Transmission & Distribution Equipmenmt	361
26.)	Electrical Industrial Apparatus	362
27.)	Household Appliances	363
28.)	Radio & TV	365
29.)	Communication Equipment	366
30.)	Electronic Components	367
31.)	Other Electrical Components	364, 369
32.)	Motor Vehicles & Parts	371
33.)	Aircraft & Parts	372, 376
34.)	Railroad Equipment	374
35.)	Shipbuilding, Military Tanks, & Other Transportation Equipment	373, 375, 379
36.)	Scientific & Engineering Instruments	381-384
37.)	Ophthalmic Goods, Watches, Clocks & Watch Cases	385, 387
38.)	Photographic Goods	386
39.)	Other Durable Goods	391, 393-396, 399
40.)	Meat Products	201
41.)	Dairy Products	202

Table 1

Industry Definitions: U.S.

	Industry Name	SIC Number
42.)	Beverages	208
43.)	Fats & Oils	207
44.)	Grain Mill, Bakery, Sugar & Confectionary & Other Food Products	203-206, 209
45.)	Tobacco Products	211-214
46.)	Broadwoven Fabrics & Other Textiles	221-222, 224, 226, 228-229
47.)	Knitting Mills	225
48.)	Floor Covering Mills	227
49.)	Apparel & Related Products	231-239
50.)	Pulp & Paperboard Mills, except Building	261-263
51.)	Building Paper	266
52.)	Paperboard Containers	265
53.)	Die-Cut Paper & Board & Other Paper Products	264
54.)	Newspapers, Books & Periodicals	271-273
55.)	Other Publishing & Printing	274-279
56.)	Industrial Chemicals, Paints & Other Chemical Products	286, 289
57.)	Drugs, Soap & Toiletries	283, 284
58.)	Fertilizers	287
59.)	Paving & Roofing Materials	295

Table 1

Industry Definitions: U.S.

	Industry Name	SIC Number
60.)	Other Petroleum Products	291, 299
61.)	Rubber Tires & Tubes	301
62.)	Other Rubber Products	302-304, 306-307
63.)	Leather, Industrial Products & Cut Stock	311, 313
64.)	Other Leather Products	314, 317, 319

Notes:

[a] Some overlap exists between "All Other Wood Products" and "Wooden Containers" in that the former includes "Wood Pallets & Skids" (SIC 2448) which should be in the latter group.

[b] Some overlap exists between "Other Stone, Clay & Glass"and "Glass Containers" in that the former includes "Pressed Brown Glass, Not Elsewhere Classified" (SIC 3229), which should be in the latter group.

[c] Some overlap exists between "Other Fabricated Metal Products" and "Building Materials & Wire Products" in that the latter includes "Wire Springs" (SIC 3495) and "Miscellaneous Fabricated Wire Products" (SIC 3496) which should be in the former group.

Table 1

Industry Definitions: Canada

Name	SIC Number (1960)
1.) Rubber Products	161,163, and 169
2.) Leather Products	174, 179
3.) Cotton Yarn and Cloth	183
4.) Woolen Yarn and Cloth	193-197
5.) Synthetic Textiles	201
6.) Miscellaneous Textiles	229
7.) Hosiery	231
8.) Other Knitting Mills	239
9.) Men's Clothing	243
10.) Women and Children's Clothing	244, 245
11.) Veneer and Plywood Mills	252
12.) Sash, Door, and Flooring Mills	254
13.) Pulp and Paper Mills	271
14.) Paper Boxes and Bags	273
15.) Other Paper	274
16.) Iron Mills	291
17.) Iron Foundries	294
18.) Non-Ferrous Metal	296-298
19.) Boilers and Plate Works	301
20.) Fabricated Structual Metals	302, 303
21.) Metal Stamping	304
22.) Wire and Wire Products	305
23.) Hardware, Cutlery and Tools	306
24.) Miscellaneous Metal Fabricating	309
25.) Agricultural Implements	311
26.) Office and Store Machinery	318

Table 1

Industry Definitions: Canada

Name	SIC Number (1960)
27.) Motor Vehicle Assembly	323
28.) Motor Vehicle Parts and Accessories	325
29.) Shipbuilding	327
30.) Major Appliances	332
31.) Radios and TV's	334
32.) Communications Equipment	335
33.) Electrical Industrial Equipment	336
34.) Electric Wire and Cable	338
35.) Miscellaneous Electrical Products	338
36.) Concrete and Clay	347, 351
37.) Glass	356
38.) Petroleum Refinery	365
39.) Pharmaceuticals	374
40.) Paints and Varnishes	375
41.) Soaps and Cleaners	376
42.) Industrial Chemicals[b]	378
43.) Scientific Equipment	381

Eight other industries - 251-Saw, Shingle and Planning Mills; 261-Household Furniture; 266-Other Furniture; 286-Commercial Printing; 289-Printing and Publishing; 307-Heating Equipment; 321-Aircraft and Parts; 393-Sporting Goods and Toys - had data available for too short a period and thus could not be used in the analysis

[b] Data are for 12 years.

For Canada, information on the time path of production is available on 51 distinct three-digit SIC industries for all or parts of the period 1960-79 from DRI-Canada, although for some industry groups information is available for earlier periods from STATCANADA. Of these 51 industries a total of 43 unique industries had data that could be matched with strike data (described below) and had information for the period 1960-1976.

Data on strike activity by SIC industry were provided by Garfield Clack of the Ontario Economic Council for the period 1947-1976. These data were merged with the production data provided by DRI and STATCANADA, yielding 42 industries with monthly data from 1960-1976, and one industry (Industrial Chemicals) with data from 1965-1976.

Of the 64 industry groups in the U.S. data set, 44 consist of a single three-digit industry; 3 consist of a single two-digit SIC industry, (obtained by summing its component three-digit industries) and each of the remaining 17 is a sum of three-digit industries, all of which are located within a given two-digit industry, but whose aggregate constitutes less than the complete two-digit industry. These 64 "industries," which comprise all of the U.S. manufacturing sector, are the entities to which the U.S. data refer.

For Canada, the same problems arise but the net result is less than full coverage of the manufacturing sector. Of the 43 industries matched, 36 consist of a single three-digit industry, 4 consist of an amalgamom of three-digit industries, and 3 consist of a single two-digit industry. These 43 groups do not completely cover the manufacturing sector, as is the case with the U.S. groupings. In 1976 they accounted for % of output, so the selectivity bias should be small.

These data yield measurements of the following variables available on a monthly basis:

1.) Shipments - Monthly value of shipments by the industry in current dollars.

2.) Inventories - Monthly value of total inventories by the industry, in current dollars.

3.) Output - Defined as $\text{Output}_t \equiv \text{Shipments}_t + (\text{Inventories}_t - \text{Inventories}_{t-1})$.

4.) Number of Strikes- The number of strikes in existence for at least one day during a given month; the sum of the number of strikes continuing from the previous month plus strikes beginning in the given month.

5.) Number of Workers Involved- The sum of the number of workers involved in all strikes occuring for one or more days during a given month.

6.) Mandays Lost - The weighted sum of the number of mandays idle for each strike in existence during a given month, with the weights being the fraction of total workdays in the month that the strike was in existence.

7.) Average Duration- The average number of work days spent in strike for strikes that began in the month.

The strike cost estimates presented in the following section are constructed from measurements of these variables. As the imperfections of these measurements may cause estimation biases to arise, it is appropriate to warn the reader before discussing the results.

(1) The construction of the production data series involves two mechanical procedures that may cause bias. The monthly records are collected from a sample of establishments with the probability of inclusion in the sample being related to employment size. To offset this, the U.S. Commerce Department "adjusts" the measured contribution of month-to-month variation in shipments (or inventories) made by any one firm whenever there is an unusually large monthly variation in the shipments of a single company that is judged to be atypical of the monthly variation in industry shipments.

The U.S. Commerce Department describes the procedure as follows:

> "From time to time, an individual company report may show unusually large changes from the previous month which differ substantially from the movement shown by the rest of the reporting panel. An example of this is the effect of a strike upon an individual company. Such extreme movements are isolated from the estimation procedure as follows: the data for the individual company are removed from the computation of the aggregate month-to-month percentage change and from the prior month's industry estimate; the modified percentage change is then applied to the reduced prior month's estimate, giving a current month's estimate of the entire industry excluding the company with the unusual month-to-month change; finally, the company's reported data are added to the modified current month's estimate to obtain the estimate for the entire industry. The effect of this procedure is to restrict the basis of estimation for nonrespondents and firms not in the survey panel to the general trend of the industry."[7] (emphasis added)

In effect, reporting units that are currently experiencing unusually large fluctuations in activity, such as might be expected from the occurrence or imminence of a strike, do not carry their normal sample weight into the calculated monthly industry data. For industries that have 100% sampling coverage this occasions no problem; but for those industries with less than full coverage, the amount of smoothing induced by this procedure will vary with the structure of collective bargaining.[8] If, for output purposes, the reporting unit is coextensive with the collective bargaining unit, and if interfirm substitution of production is confined to the industry, the Census procedure will generate "correct" results, but these conditions are not always satisfied. In our judgment, the Census procedure usually has the effect of reducing the measured correlation of strike activity and output, leading to an underestimate of the output loss due to strikes. We have been unable to determine the exact adjustment procedures used by STATCANADA but we expect they are similar.

(2) Using output data (output defined as shipments plus change in inventories) to measure strike costs is appropriate only if inventories consist exclusively of final (i.e., finished) goods. This is because changes in inventories of final goods reflect current productive activity, while changes in inventories of raw materials do not. Unfortunately, at the three-digit (industry) level only total inventories are reported, and hence what is measured as output includes changes in (total) inventories and will therefore be biased up or down to the extent that stocks of raw materials have changed.

To avoid this difficulty, we have used shipments rather than output as the instrument for measuring the cost of strikes. Over a long period of time shipments and output will vary similarly, but their short period movements may differ, with those in shipments will more nearly reflecting the impact of strikes on productive activity than those in "output."

(3) Strike data also present conceptual problems. These data are not a sample; they purport to be a complete count of the number of strikes occurring. However, the method by which the data are collected, namely from newspaper accounts and reports from state labor departments, raises doubts about the completeness of coverage. Presumably, large strikes of "normal" length are accurately reported. But short strikes (e.g., less than three days), or strikes involving small numbers of workers, may be overlooked.

Also where very long strikes (e.g., longer than one year) are reported, but without a termination date, it becomes unclear as to whether (i) the firm ceased operating or (ii) was able to continue operation without the strikers. In either event, "strike length" becomes ambiguous.[9]

Having issued these caveats, we remind the reader that these are the only data available for assessing the impact of strike activity on industry output in U.S. and Canadian manufacturing, and affirm that we believe them to be "reasonably accurate." We shall not make further reference to these reservations, although we have borne them in mind in constructing the cost estimates presented in the following section.

III. Estimates of Strike Cost

It is convenient to present our results in two stages: (1) the relationship of output (shipments) to strike activity and (2) the implications for strike cost of the findings reported under (1).

(1) The Impact of Strike Activity on Shipments

The vector autoregressions described in Section II were fitted to monthly shipment and strike data for the sixty-three U.S. and forty-three Canadian industries that reported strikes in the 1958-77 and 1960-76 periods.[10] Shipments were entered in logarithmic form and the effect of strike activity on shipments is therefore measured by month-to-month percentage changes in the latter in response to absolute changes in the former. To measure strike activity we used mandays idle (in 10,000's) during the month. Both equations also include monthly dummy variables and a time trend. After some experimentation, the maximum number of lags in shipments and/or in strike variables was set at twenty-four. In no industry would it have been appropriate to permit lags as long as 36 months, while suppressing lags longer than twelve months would have been clearly inappropriate in a number of cases. To avoid influencing cross-industry comparisons by the imposition of lag structures that differ from one industry to another, we have allowed all industries to have lags up to 24 months.

It is not particularly informative to present the individual autoregressive parameters because, as in macro studies (e.g., Sims (1980)), they alternate in sign and tend to be highly correlated. Moreover, as noted above the individual coefficients do not have a structural interpretation. Instead we present estimates of the "contemporaneous" and the total or cumulative effect of strike activity on output.

In columns 1 and 2 of Table 2, we present the marginal significance level at which the "hypothesis of no effect" can be rejected using the asymptotic chi-square distribution with the degrees of freedom adjustment of Sims (1980). That is, these entries give the level of Type I error that must be accepted in order to reject the null hypothesis of no effect; the results are summarized in the left-hand column of Table 3. In less than half of the industries can the null hypothesis be rejected at conventional significance levels. At the 5 percent level, in only 24 (out of 63) and 7 of 43 Canadian manufacturing industries can we reject the null hypothesis; at the 10 percent level, in only 27 U.S. and 9 Canadian industries can the null hypothesis be rejected.

The difference in the null hypotheses tested in columns 1 and 2 of Table 2 (and, analogously, in columns 3 and 4) is as follows. The reference model is:

Table 2

Marginal Significance Levels of
Tests of the Hypotheses that Strikes Affect Output (Columns 1 and 2)
and that Output Affects Strikes (Columns 3 and 4):^{a} U.S. and Canada

	Output		Strike Activity	
	Lagged Strike Activity (1)	Lagged Strike Activity plus Contemporaneous Shipment-Strike Interaction (2)	Lagged Shipments (3)	Lagged Strike Activity plus Contemporaneous Shipment-Strike Interaction (4)
U.S.				
1.) Wooden Container	.3079	.3600	.7124	.7629
2.) All Other Wood Products	.9229	.8414	.0105	.0078
3.) Household Furniture	.4173	.4512	.5414	.5747
4.) All Other Furniture	.2720	.3178	.6214	.6721
5.) Glass Containers	.0312	.0001	.0261	.0022
6.) Kitchen Articles	.0001	.0001	.0261	.0104
7.) Other Stone Clay & Glass	.1262	.0743	.0001	.0001
8.) Blast Furnaces & Steel Mills	.5131	.1791	.2432	.0632
9.) Iron & Steel Foundaries	.0023	.0025	.9992	.9982
10.) Other Primary Metal	.3609	.3790	.9594	.9631
11.) Metal Cans, Barrels & Drums	.0001	.0001	.7698	.7139
12.) Cutlery, Handtools, & Hardware	.9231	.9418	.9994	.9996
13.) Building Materials & Wire	.9288	.9442	.3287	.3752
14.) Ordnance & Accessories	.0001	.0001	.0298	.0357
15.) Other Fabricated Metal Products	.9900	.9930	.9492	.9620
16.) Steam Engines, Turbines, & Internal Combustion Engines	.7708	.6974	.9985	.9930
17.) Farm Machinery & Equipment	.8405	.8291	.0230	.0230
18.) Construction & Mining Equipment	.0001	.0001	.9609	.6243
19.) Metal Working Machinery	.4181	.3602	.0742	.0611
20.) Machine Shops	.0019	.0028	.5278	.5770
21.) Special Industry Machinery	.9956	.9948	.9979	.9974
22.) Office & Store Machinery	.9817	.9856	.9944	.9956

Table 2

Marginal Significance Levels of
Tests of the Hypotheses that Strikes Affect Output (Columns 1 and 2)
and that Output Affects Strikes (Columns 3 and 4):[a] U.S. and Canada

		Output		Strike Activity	
		Lagged Strike Activity (1)	Lagged Strike Activity plus Contemporaneous Shipment-Strike Interaction (2)	Lagged Shipments (3)	Lagged Strike Activity plus Contemporaneous Shipment-Strike Interaction (4)
	U.S.				
23.)	Service Industry Machinery	.9982	.9982	.0664	.0870
24.)	Electrical Transmission Equipment	.0001	.0001	.9900	.9933
25.)	Electrical Industrial Apparatus	.0180	.0175	.3263	.3081
26.)	Household Appliances	.0690	.0876	1.0000	1.0000
27.)	Radios & Televisions	.0001	.0001	.9679	.8980
28.)	Communications Equipment	.4305	.3210	.9891	.9582
29.)	Electronic Components	.1098	.0848	1.0000	.9994
30.)	Other Electronic Components	.0011	.0010	.8019	.7519
31.)	Motor Vehicles & Parts	.6545	.6842	.0373	.0456
32.)	Aircraft & Parts	.0001	.0001	.8360	.7663
33.)	Railroad Equipment	.0001	.0001	.8284	.8422
34.)	Shipbuilding & Other Transportation	.6507	.7070	.0144	.0205
35.)	Scientific Instruments	.0001	.0001	.8284	.8422
36.)	Opthalmic Goods & Watches	.1040	.0927	.9995	.9981
37.)	Photographic Goods	.7583	.8054	.9554	.9688
38.)	Other Durable Goods	.6559	.7056	.9092	.9300
39.)	Meat Products	.4656	.3277	.0028	.0015
40.)	Dairy Products	.0001	.0001	.5491	.4903
41.)	Beverages	.9867	.9873	.0132	.0162
42.)	Fats & Oils	.0001	.0001	.9988	.9790
43.)	All Other Foods	.5589	.6197	.2792	.3321
44.)	Tobacco	.0001	.0001	.9988	.9790
45.)	Broadwoven Fabrics	.0148	.0187	.4171	.4505
46.)	Knitting Mills	.4111	.4640	.9946	.9963
47.)	Floor Coverings	.0001	.0001	.1742	.1984

Table 2

Marginal Significance Levels of
Tests of the Hypotheses that Strikes Affect Output (Columns 1 and 2) and that Output Affects Strikes (Columns 3 and 4):[a] U.S. and Canada

	Output		Strike Activity	
	Lagged Strike Activity (1)	Lagged Strike Activity plus Contemporaneous Shipment-Strike Interaction (2)	Lagged Shipments (3)	Lagged Strike Activity plus Contemporaneous Shipment-Strike Interaction (4)
U.S.				
48.) Apparel	.2981	.3227	.0001	.0001
49.) Pulp & Paperboard	.0312	.0190	.9156	.8168
50.) Building Paper	.9301	.8995	.9978	.9941
51.) Paperboard Containers	.7856	.8006	1.000	1.000
52.) Other Paper	.9720	.9804	.9972	.9982
53.) Newspapers, Books & Periodicals	.9935	.9956	.0197	.0270
54.) Other Publishing	.0040	.0056	.9875	.9901
55.) Industrial Chemicals & Paints	.9710	.9767	.9789	.9831
56.) Drugs, Soaps & Toiletries	.0034	.0029	.7330	.6626
57.) Fertilizers	.0008	.0010	.9889	.9875
58.) Paving & Roofing Materials	.4696	.5233	.9986	.9990
59.) Other Petroleum Products	.8549	.7251	.0001	.0001
60.) Rubber Tires & Tubes	.2162	.2167	1.0000	1.0000
61.) Other Rubber Products	.0001	.0001	.9300	.9381
62.) Industrial Leather Products	.0001	.0001	.7594	.7920
63.) Other Leather Products	1.0000	1.0000	.4391	.5002

---

[a] The marginal significance values are the right-tail areas of the x^2 distribution calculated under the null hypothesis. Columns (1) and (3) are $\chi^2(24)$ and columns (2) and (4) are $\chi^2(25)$.

Table 2

Marginal Significance Levels of Tests of the Hypothesis that Strikes Affect Output (Columns 1 and 2) and that Output Affects Strikes (Columns 3 and 4):[a] U.S. and Canada

Industry	Shipments: Lagged Strike Activity (1)	Shipments: Lagged Plus Contemporaneous Strike Activity (2)	Strikes: Lagged Shipments (3)	Strikes: Lagged Plus Contemporaneous Shipments (4)
Canada				
1. Rubber Products	.3253	.0825	.2726	.3677
2. Leather Products	.0221	.0255	.0650	.0770
3. Cotton, Yarn & Cloth	.3650	.2850	.3461	.0202
4. Woolen Yarn & Cloth	.2518	.2775	.0386	.3465
5. Synthetic Textiles	.6113	.6708	.0694	.0917
6. Misc. Textiles	.4875	.3252	.6592	.4770
7. Hosiery	.9740	.9773	.4830	.5001
8. Other Knitting Mills	.6030	.6585	.8298	.8563
9. Men's Clothing	.7172	.5248	.8101	.6283
10. Women & Children's Clothing	.9798	.3813	.5872	.6193
11. Veneer & Plywood Mills	.6582	.6828	.7505	.7704
12. Sash, Door, & Flooring Mills	.6486	.6931	.8761	.8990
13. Pulp & Paper Mills	.0028	.0002	.4652	.0053
14. Paper Boxes & Bags	.3400	.3100	.0202	.0187
15. Other Paper	.7980	.8234	.8382	8599
16. Iron Mills	.0050	.0001	.3944	.0001
17. Iron Foundries	.4714	.4095	.3254	.2772
18. Non-Ferrous Metal	.9384	.8707	.6658	.5507
19. Boilers & Plate Works	.7470	.7067	.3941	.4878
20. Fabricated Structural Metals	.5744	.4816	.9038	.8360
21. Metal Stamping	.0741	.0672	.7269	.6820
22. Wire & Wire Products	.2993	.2994	.5302	.5243
23. Hardware, Cutlery & Tools	.6159	.6179	.9335	.5997
24. Misc. Metal Fabricating	.3874	.3916	.1797	.2201
25. Agricultural Implements	.0602	.0172	.7514	4240
26. Office & Store Machinery	.3810	.3866	.8221	.8570
27. Motor Vehicle Assembly	.5401	.1893	.0083	.0013
28. Motor Vehicle Parts & Accessories	.0001	.0001	.3990	.3833
29. Shipbuilding	.3860	.3819	.1801	.1309
30. Major Appliances	.2903	.3335	.5489	7052
31. Radios & TV's	.2500	.2952	.2494	2940
32. Communications Equip.	.8091	.7043	.0143	.0098
33. Electrical Industrial Equipment	.3637	.2293	.6813	.4984
34. Electric Wire & Cable	.5449	.4469	.3722	2934
35. Misc. Electrical Prod.	.4298	.2701	.3757	2307
36. Concrete & Clay	.3719	.7549	.3688	.3066
37. Glass	.4105	.4254	.7007	.7090
38. Petroleum Refinery	.3102	.2958	.2792	.2908
39. Pharmaceuticals	.0095	.0005	.4659	0839
40. Paints & Varnishes	.0872	.0894	.8937	.3097
41. Soaps & Cleaners	.0331	.0199	.0156	.0097
42. Industrial Chemicals[7]	9017	.8775	.1575	.1518
43. Scientific Equipment	.3543	.3432	.4411	.4297

Table 3

Panel A - U.S.

	Strikes Affect Output	Strikes Do Not Affect Output
Output Affects Strikes	3	10
Output Does not Affect Strikes	22	28

Joint Distribution of Industries with Significant Strike and Output Affects, 5% Level.

	Strikes Affect Output	Strikes Do Not Affect Output
Output Affects Strikes	4	13
Output Does not Affect Strikes	24	22

Joint Distribution of Industries with Significant Strike and Output Affects, 10% Level.

Panel B

Canada

3	5
4	31

6	6
3	28

$$(8) \quad Z_t = \begin{Bmatrix} Q_t \\ S_t \end{Bmatrix} = \begin{bmatrix} A_{11}(L) & A_{12}(L) \\ A_{21}(L) & A_{22}(L) \end{bmatrix} \cdot Z_{t-1} + \begin{bmatrix} W_{11} & W_{12} \\ W_{21} & W_{22} \end{bmatrix} \cdot \begin{Bmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \end{Bmatrix}$$

where A_{ij} is a polynomial of order 24. The hypothesis that strikes and output are independent processes is equivalent to $A_{12}(L) = A_{21}(L) = W_{12} = W_{21} = 0$ for all L. Because of the large number of lags in the model, we present the results of two tests: In column (1) (and analogously in column 3) we test $A_{12}(L) = 0$ ($A_{21}(L) = 0$) relative to the base model given in (8). This provides a test of the effect of lagged strike activity on output. To test the effect of both lagged and contemporaneous strike activity on output we impose the constraints $A_{12}(L) = W_{12} = 0$ which are reported in column 2. These results are given in Table 2. Note that these tests are subsets of the more general proposition of complete independence described above.

Columns 3 and 4 are analogous to columns 1 and 2, but refer to the strike activity regressions instead of the output regressions. The rationale of our procedure is the same as that for the output regressions, mutatis mutandis. It is clear (from figure 2) that, in U.S. manufacturing, strikes affect output more frequently than output affects strikes, though there are enough examples (12) where output affects strikes significantly (at the 10 percent criterion), to make one uneasy about assuming "one-way" causality without additional information.

For Canada, output significantly affects strike activity in a few more industries than strike activity affects output. However, even at the 10 percent level, in almost two-thirds of the industries we were unable to reject the hypothesis of no affect in either direction. The possible reasons for the inter-country differences are discussed below.

(a) The Effect of Output on Strike Activity: A Digression

As already remarked, the regressions underlying columns 3 and 4 of Appendix Table 2 are an "inverse" of those underlying columns 1 and 2. That is, the regressions underlying columns 3 and 4 regress strike activity on current and lagged output, while those underlying 1 and 2 regress output on strike activity, current and lagged. Although it is not, strictly speaking, part of our primary objective, we report the regression of strike activity on shipments both because of its substantive interest and as an important check on the validity of the interpretations to be placed upon our findings.

Substantive interest in regressions of strike activity on output derives from the considerable literature relating strikes to output (e.g., to phases of the business cycle) of which Rees (1952), Ashenfelter and Johnson (1969), and Scully (1971) are leading examples. However, these and most other studies of the genre deal with the effect of output on strikes at the aggregate level only, while we study the effect at the level of individual industries.

In the present context it is important to remark that, in the U.S., those industries in which strikes have a negative and significant effect on output are generally different from those in which shipments have a significant effect on strikes. As Table 3 shows, in only two industries is there a significant effect (either at the 5 or the 10 percent criterion) of both strikes on shipments and of shipments on strikes. We stress this finding to allay any suspicion that the reported effect of strike activity on shipments might be spurious and result from intercorrelation of disturbances in the two series. Table 3 makes clear that this is not hte case: the industries where strike activity affects shipments have almost no overlap with those where shipments affect strike activity.

The 3 (or 4 at the 10 percent level) industries in the northwest cell of Panel A Table 3 (i.e., the only industries where there is both an effect of strike activity upon shipments, and vice-versa), are Glass Containers (No. 5), Kitchen Articles (No. 6) and Ordinance and Accessories (No. 14). The paucity of entries in this cell indicates that, for the U.S., two-directional causation is the exception rather than the rule.

The situation is somewhat different in Canadian manufacturing. At both the 5 and 10 percent criteria (especially the latter) the entries in the northwest cell of Table 3 relative to the total are appreciably larger than for the U.S. The relative size of the northwest cell becomes even larger when we eliminate the southeast (no effect) cell. In nuce, the fraction of Canadian industries where a significant effect in either direction (strikes on output or output on strikes) is appreciably smaller than of U.S. industries. And of those industries in which a significant effect can be found, an appreciably greater fraction are in the two direction (northwest cell) in Canada.

Our explanation of this is as follows: as will be seen, output substitution over time is much more effective in offsetting loss from strikes in Canadian manufacturing than in U.S. Therefore, in Canada strike associated output variation that is diffused over time is less likely to involve net output loss (i.e., output losses during strikes are more fully recouped before and/or after) than in the U.S.; hence the relatively small entries in the northwest and southwest cells of Panel B of Table 3. Conversely, those industries in which strikes are associated with significant net output loss are those where the impact upon output is largely contemporaneous with the strike; i.e., a big part of such output loss as occurs, occurs with lag zero. Lag zero effects are, by definition, two-directional.

(2) The Cost of Strike Activity

(a) Magnitude

We measure strike activity in a given month as number of man-days of strike activity in that month, and term a strike of 10,000 man-days a strike unit. The cost of strike activity in month t is the sum of the impact of strike activity in month t on shipments in month t and all subsequent months from 1 through 24. This effect is estimated from the vector autoregressions described in section II.[11]

(i) Contemporaneous Effect

On average, in the manufacturing sector as a whole, a unit strike leads to a barely perceptible decline in current shipments--less than 1/1000 of one percent.[12] Although a positive contemporaneous (i.e., lag zero) effect of strike activity on shipments is anomalous, it can hardly be termed unusual in light of column 1 of Table 4. As this column shows, for the U.S. 28 of the 63 industries studied (44%) exhibit a positive contemporaneous correlation of strike and shipment innovations; for Canada, 11 of 43 industries (26%) exhibit similar positive correlation. As intuition strongly suggests that the contemporaneous effect of strike activity on shipments should be negative (i.e., output should be lower than otherwise during a strike), this result requires explanation.

Two explanations seem possible. (1) During short intervals shipments and production can diverge because of variations in inventories although, as already remarked, movements in shipments and production ultimately must tend to converge. Consequently, the contemporaneous effect of a strike on

Table 4

Percentage Change in Shipments
Per 10,000 Man-days of Strike Activity, Contemporaneous and Total, U.S. and Canada

Industry	(1) Contemporaneous Effect	(2) Total Effect
U.S.		
1.) Wooden Container	.0089	1.1563
2.) All Other Wood Products	.0005	-.0074
3.) Household Furniture	-.0033	-.0439
4.) All Other Furniture	-.0021	-.1248
5.) Glass Containers	-.0060	-.0065
6.) Kitchen Articles	.0250	.2665
7.) Other Stone Clay & Glass	-.0063	-.0522
8.) Blast Furnaces & Steel Mills	-.0106	-.2137
9.) Iron & Steel Foundries	-.0027	-.1536
10.) Other Primary Metal	-.0006	.0116
11.) Metal Cans, Barrels & Drums	.0164	.1199
12.) Cutlery Handtools & Hardware	.0021	-.1527
13.) Building Materials & Wire	-.0010	.0487
14.) Ordnance & Accessories	.0153	-3.9843
15.) Other Fabricated Metal Products	-.0010	.0520
16.) Steam Engines, Turbines, & Internal Combustion Engines	-.0029	.0161
17.) Farm Machinery & Equipment	-.0018	.0161
18.) Construction & Mining Equipment	-.0023	.0304
19.) Metal Working Machinery	.0024	.0869
20.) Machine Shops	-.0039	-.1418
21.) Special Industry Machinery	.0047	-.0500
22.) Office & Store Machinery	-.0016	.0383
23.) Service Industry Machinery	.0007	-.0692
24.) Electrical Transmission Equipment	.0008	.2232
25.) Electrical Industrial Apparatus	.0041	.2104
26.) Household Appliances	-.0006	-.0346
27.) Radios & TV	-.0172	-.3008
28.) Communication Equipment	-.0009	.0088

Table 4

Percentage Change in Shipments
Per 10,000 Man-days of Strike Activity, Contemporaneous and Total,
U.S. and Canada

Industry	(1) Contemporaneous Effect	(2) Total Effect
29.) Electronic Components	.0030	.0783
30.) Other Electronic Components	.0032	-.0994
31.) Motor Vehicles & Parts	-.0005	-.0001
32.) Aircraft & Parts	.0012	-.0431
33.) Railroad Equipment	.0046	-.3847
34.) Shipbuilding & Other Transportation	.0001	.0131
35.) Scientific Instruments	-.0115	-.4852
36.) Opthalmic Goods & Watches	-.0255	-.4006
37.) Photographic Goods	-.0006	.2450
38.) Other Durable Goods	-.0011	-.0039
39.) Meat Products	.0030	-.0406
40.) Dairy Products	-.0095	-.6953
41.) Beverages	-.0017	-.0355
42.) Fats & Oils	.0035	-.3408
43.) All Other Foods	-.0001	-.0261
44.) Tobacco	.0035	-.3851
45.) Broadwoven Fabrics	-.0011	-.1491
46.) Knitting Mills	.0076	-.0395
47.) Floor Coverings	.0342	.4189
48.) Apparel	.0005	-.0034
49.) Pulp & Paperboard	-.0047	-.1929
50.) Building Paper	-.0090	-.1450
51.) Paperboard Containers	-.0042	-.1799
52.) Other Paper	.0014	-.0575
53.) Newspapers, Books & Periodicals	-.0003	-.0136
54.) Other Publishing	.0023	-.2047
55.) Industrial Chemicals & Paints	.0008	-.0342
56.) Drugs, Soaps & Toiletries	-.0053	-.1628
57.) Fertilizers	-.0233	-1.1926
58.) Paving & Roofing Materials	.0141	-.4749

Table 4

Percentage Change in Shipments
Per 10,000 Man-days of Strike Activity, Contemporaneous and Total, U.S. and Canada

Industry	(1) Contemporaneous Effect	(2) Total Effect
59.) Other Petroleum Products	-.0047	.1572
60.) Rubber Tires & Tubes	.0008	.0105
61.) Other Rubber Products	-.0014	-.1252
62.) Industrial Leather Products	.0142	-.7709
63.) Other Leather Products	.0003	.0585

Table 4

Percentage Change in Shipments per 10,000 Man-days of Strike Activity, Contemporaneous and Total, U.S. and Canada

Industry	Contemporaneous Effect	Total Effect
Canada		
1.) Rubber Products	-.1029	-.1493
2.) Leather Products	.0315	1.7584
3.) Cotton Yarn & Cloth	-.0228	-.0509
4.) Woolen Yarn & Cloth	.0711	2.4192
5.) Synthetic Textiles	-.0013	-.6007
6.) Misc. Textiles	-.2293	-.1405
7.) Hosiery	-.1236	-4.1029
8.) Other Knitting Mills	.0128	.3632
9.) Men's Clothing	-.0080	.0261
10.) Women & Children's Clothing	-.15164	-7.0294
11.) Veneer and Plywood Mills	-.0070	.1544
12.) Sash, Door, & Flooring Mills	.0403	-4.0892
13.) Pulp & Paper Mills	-.0042	-.0842
14.) Paper Boxes & Bags	-.0119	-.0611
15.) Other Paper	.0177	-1.0287
16.) Iron Mills	-.0070	-.0223
17.) Iron Foundries	.0329	-.2784
18.) Non-Ferrous Metal	-.0222	.2241
19.) Boilers & Plate Works	-.0630	.9415
20.) Fabricated Structural Metals	-.0508	-.2055
21.) Metal Stamping	.0253	.0630

Table 4

Percentage Change in Shipments per 10,000 Man-days of Strike Activity, Contemporaneous and Total, U.S. and Canada

Industry	Contemporaneous Effect	Total Effect
22.) Wire & Wire Products	.0281	-.1199
23.) Hardware, Cutlery & Tools	-.0238	-.0502
24.) Misc. Metal Fabricating	-.0018	-.1904
25.) Agricultural Implements	-.0176	.1254
26.) Office & Store Machinery	.0246	.1470
27.) Motor Vehicle Assembly	-.0077	.0017
28.) Motor Vehicle Parts & Accessories	-.0056	-.0118
29.) Shipbuilding	-.0240	.1945
30.) Major Appliances	.0013	.3335
31.) Radios & TV's	-.0153	-.4895
32.) Communications Equipment	-.0075	.0969
33.) Electrical Industrial Equipment	-.0165	-.0708
34.) Electric Wire & Cable	-.0361	-.0954
35.) Misc. Electrical Prod.	-.0501	-1.0435
36.) Concrete & Clay	-.0615	1.2962
37.) Glass	-.0377	.2888
38.) Petroleum Refinery	-.0117	-.4674
39.) Pharmaceuticals	-.1251	-6.3775
40.) Paints & Varnishes	-.0162	-.3977
41.) Soaps & Cleaners	-.1694	-1.8939
42.) Industrial Chemicals[b]	.0190	1.0900
43.) Scientific Equipment	-.0166	.6440

production could be negative although the (short-run) effect on shipments was positive. Wherever this is the case, the covariance of innovations in strikes and inventory changes must exceed the covariance in strike and production (output) innovations.

(2) A different explanation can be offered, based on the discrete nature of the data on shipments.[13] For example, an output "surge" might occur during the early part of a month due to a pre-strike inventory buildup, although the strike commenced on the last day or two of the month. This would be recorded as a month with (say) two days of strike and 20 days of super-normal output; even less extreme cases could contribute to the illusion of a positive effect of strike activity on output.[14] This dating problem, of course also blurs the allocation of the impact of a strike on output as between contemporaneous and delayed effects.

(ii) Cumulative Effect

Turning now to the cumulative or total effect of strikes on output, given in column 2 of Table 4, we find that for U.S. manufacturing as a whole, the effect of an average amount of strike activity was to reduce monthly shipments by about .15% (.0015), and for Canadian manufacturing it was .44% (.0044). This average is calculated including those industries that show "no significant" relation of strikes and output. If only those industries that exhibit a "significant" relationship of strikes and output are considered, (i.e., industries with an MSL of 5% or less), the average effect is -.37% in the U.S. and -.74% for Canada.

By almost any criterion these estimated effects of strike activity on output are small. A sense of the actual magnitudes of these effects is conveyed by the dollar amounts involved which are presented in column 1 of Appendix Table 5 where we present estimates of the cost of an "average" strike

Table 5

Measures of Strike Cost: U.S. and Canada

U.S.			Canada		
Industry Name	Cost per Strike in 000's of 1972 Dollars	Cost of Strikes as a Percentage of Annual Output	Industry Name	Cost per Strike in 000's of 1972 Dollars	Cost of Strikes as a Percentage of Annual Output
1.) Wooden Containers	-111.5	-.0017	1.) Rubber Products	56.7	.0015
2.) Wood Buildings* & Mobile Homes	-	-	2.) Leather Products	-89.4	-.0014
3.) All Other Wood Products	25.0	.0002	3.) Cotton Yarn & Cloth	17.3	.0003
4.) Household Furniture	36.7	.0006	4.) Woolen Yarn & Textiles	-78.3	-.0014
5.) All Other Furniture	62.9	.0011	5.) Synthetic Textiles	194.5	.0024
6.) Glass Containers	7.8	.0001	6.) Misc. Textiles	.3	.0001
7.) Kitchen Articles	-19.8	-.0014	7.) Hosiery	57.5	.0008
8.) Other Stone, Clay & Glass	153.6	.0021	8.) Other Knitting Mills	-26.2	-.0005
9.) Blast Furnaces & Steel Mills	1698.6	.0067	9.) Men's Clothing	-3.0	-.0001
10.) Iron & Steel Foundries	274.2	.0049	10.) Women's & Children's Clothing	157.8	.0007
11.) Other Primary Metal Products	-85.4	-.0007	11.) Veneer & Plywood Mills	-17.9	-.0005
12.) Metal Cans, Barrels & Drums	-82.7	-.0004	12.) Sash, Door & Flooring Mills	76.9	.0021
13.) Cutlery, Handtools & Hardware	60.8	.0017	13.) Pulp & Paper Mills	14.4	.0002
14.) Building Materials & Wire Prod.	-163.1	-.0025	14.) Paper Boxes & Bags	94.4	.0013
15.) Ordinance & Accessories	1348.4	.0154	15.) Other Paper	27.2	.0004
16.) Other Fabricated Metal Prod.	-186.3	-.0018	16.) Iron Mills	19.7	.0008
17.) Steam Engines, Turbines & Internal Combustion Engines	73.5	.0009	17.) Iron Foundries	-27.2	-.0010
18.) Farm Machinery & Equipment	54.6	-.0004	18.) Non-Ferrous Metal	-8.4	-.0006
19.) Construction, Mining & Material Handling Equipment	-129.	-.0011	19.) Boilers & Plate Works	19.7	.0007
20.) Machinery, Misc. Equip. & General Industry Machinery	-445.2	-.0049	20.) Fabricated Structural Metals	-7.1	-.0001
21.) Machine Shops	93.7	.0011	21.) Metal Stamping	7.8	.0002
22.) Special Industry Machinery	73.9	.0007	22.) Wire & Wire Products	2.4	.0001
23.) Office & Store Machinery	-220.7	-.0004	23.) Hardware, Cutlery & Tools	29.3	.0008
24.) Service Industry Machinery	160.7	.0014	24.) Misc. Metal Fabricating	-25.8	-.0005

Table 5

Measures of Strike Cost: U.S. and Canada

U.S.

Industry Name	Cost per Strike in 000's of 1972 Dollars	Cost of Strikes as a Percentage of Annual Output
25.) Electrical Transmission & Distribution Equipment	-143.2	-.0035
26.) Electrical Industrial Apparatus	-310.4	-.0030
27.) Household Appliances	148.9	.0010
28.) Radio & TV	1238.0	.0041
29.) Communications Equipment	-88.0	-.0002
30.) Electronic Components	-190.0	-.0002
31.) Other Electronic Components	200.7	.0019
32.) Motor Vehicles & Parts	17.8	.0001
33.) Aircraft & Parts	943.2	.0017
34.) Railroad Equipment	381.8	.0028
35.) Shipbuildings, Military Tanks & Other Transportation Equipment	-54.6	-.0006
36.) Scientific & Engineering Instruments	1,193.7	.0062
37.) Ophthalmic Goods, Watches, Clocks & Watch Cases	-99.5	.0006
38.) Photographic Goods	-234.9	-.0002
39.) Other Durable Goods	6.3	.0001
40.) Meat Products	375.8	.0010
41.) Dairy Products	538.2	.0017
42.) Beverages	75.8	.0006
43.) Fats & Oils	591.0	.0010
44.) Grain Mill, Bakery, Sugar, Confectionary & Other Food Products	234.8	.0010
45.) Tobacco Products	1,608.0	.0015
46.) Broadwoven Fabrics & Other Textiles	452.0	.0017

Canada

Industry Name	Cost per Strike in 000's of 1972 Dollars	Cost of Strikes as a Percentage of Annual Output
25.) Agricultural Implements	-4.6	-.0001
26.) Office & Store Machinery	-7.1	-.0001
27.) Motor Vehicle Assembly	11.3	.0002
28.) Motor Vehicle Parts & Acces.	-32.6	-.0013
29.) Shipbuilding	-32.8	-.0013
30.) Major Appliances	-74.1	-.0015
31.) Radio & TV	21.8	.0003
32.) Communications Equipment	-85.8	-.0001
33.) Electrical Industrial Equip.	15.3	.0003
34.) Electric Wire & Cable	8.4	.0001
35.) Misc. Electrical Products	106.9	.0017
36.) Concrete & Clay	-122.7	-.0022
37.) Glass	-38.9	-.0022
38.) Petroleum Refinery	416.0	.0008
39.) Pharmaceuticals	549.2	.0043
40.) Paints & Varnishes	8.9	.0001
41.) Soaps & Cleaners	44.8	.0004
42.) Industrial Chemicals	-300.6	-.0028
43.) Scientific Equipment	-80.8	-.0007

Table 5

Measures of Strike Cost: U.S. and Canada

U.S.

Industry Name	Cost per Strike in 000's of 1972 Dollars	Cost of Strikes as a Percentage of Annual Output
47.) Knitting Mills	28.6	.0001
48.) Floor Covering Mills	-59.7	-.0002
49.) Apparel & Related Prod.	12.9	.0001
50.) Pulp & Paperbound Mills, Except Building	805.6	.0041
51.) Building Paper	34.6	.0006
52.) Paperboard Containers	189.2	.0015
53.) Die-Cut Paper & Board & Other Paper Products	74.7	.0005
54.) Newspapers, Books & Periodicals	180.8	.0005
55.) Other Publishing & Printing	470.7	.0023
56.) Industrial Chemicals, Paints & Other Chemical Products	339.4	.0017
57.) Drugs, Soaps, & Toiletries	723.1	.0015
58.) Fertilizers	1,162.8	.0039
59.) Paving & Roofing Materials	61.4	.0006
60.) Other Petroleum Products	-4,415.9	-.0023
61.) Rubber Tires & Tubes	-42.0	-.0004
62.) Leather, Industrial Products & Cut Stock	314.2	.0033
63.) Other Leather Products	104.6	.0009
64.)	34.0	.0004

for each manufacturing industry in each country. As these figures indicate, in both countries the cost of an average strike is "small."[15] Confining our calculations to the 19 U.S. and 6 Canadian industries that have significant (at 10 percent) and positive average strike costs, the average output loss (per strike) is .6 million dollars ($600,000) in the U.S., with the most expensive strikes occurring in Broadwoven Fabrics where the average output loss was $1.6 million. In Canada, the average loss per strike for the above industries was $116,000, with Pharmaceuticals ($549,000) having the most costly strikes.

The costliness of the institution of the strike depends not only upon the mean cost per strike, but also upon the frequency of strikes. Strike frequency is conveniently measured as number of strikes per year and the product, number of strikes per year times mean cost per strike, as a percentage of output per year is a good measure of the fraction of annual output lost due to strike activity.

Such a measure is presented in column (2) of Table 5. This column presents estimates of the annual percentage loss in output due to strike activity; i.e., column (2) is the product of column (2) in Table 3 and average annual mandays idle, divided by annual shipments. In all cases , save for Ordnance and Accessories in the U.S., annual output lost due to strikes is less than one half of one percent per year of total shipments; this statement covers both countries.[16] In U.S. Ordnance and Accessories the annual loss is about 1.5 percent of shipments which, while not large in an absolute sense, is about ten times greater than that of any other industry in this study.

To observe this measurement procedure in operation, let us see how it operates to assess the cost of an unusually large strike, i.e., one that might occasion government intervention under popular Canadian and U.S. definitions of emergency strikes. As an example, consider the "Great Steel Strike of 1959."

As background we note that this strike was the largest (i.e., involved the largest number of mandays idle) ever experienced in United States history. The 41.9 million mandays idle due to this one strike, was exceeded by the mandays lost due to strikes for the entire economy, in only nine of the years between 1945 and 1977. The strike began on July 15, 1959 and was halted by injunction on November 7. While not all steel producers were involved, without doubt this was a strike of mammoth proportions, and both contemporary and later accounts implied that there were large losses suffered by both parties.

Of the 41.9 million man-days lost, 36.3 million were in primary metals--36.1 in Blast Furnaces and Steel Mills (SIC 331) and 200,000 in the rest of the industry (SIC's 332-339). Using the estimates of Table 4 we calculate that the percent of monthly output lost due to the Great Steel Strike was -36.1 million/10 thousand x .002137 = 6.75% of average monthly output in Blast Furnaces, and 225,000/10,000 x -.001530 = .03% of average monthly output in the rest of primary metals.[17] On an annual basis this amounts to a loss of .6% of output, about 5 times greater than the average annual loss due to strikes in these industries. N.B.: This estimated output (shipment) loss is what is attributable to the largest strike in U.S. history!

(b) Accuracy

Before attempting further to interpret these findings, let us appraise their accuracy. In particular, let us consider the possibility that the average cost of a strike typically appears small because of imperfections of the measurement procedures used, rather than the characteristics of the phenomena measured. In attempting this it is convenient to distinguish several distinct, though related, questions.

As can be seen from Table 5, of the 28 U.S. industries having MSL's of 10% or lower (only) 19 had negative signs (of the effect of strike activity on output); i.e., in only 19 industries did greater strike activity reduce shipments "significantly." It is only in these 19 industries that the adverse effect of strike activity on industry output is judged to be considered sufficiently large to be significantly different from zero. Similarly in Canada, of the 9 industries with MSL's no greater than 10%, only 6 had negative signs.

Of the U.S. industries where strikes do not appear to have a significant effect on output, 15--roughly 50%--have a (measured) positive total effect. These industries are dismissed as cases where cost per strike is indistinguishable from zero, though presumably positive. The six U.S. industries where average strike cost is negative, and the MSL is below 5 percent, cannot be dismissed so easily; we treat these as anomalies to be explained. In 23 of the 38 industries whose column 1 entry in Appendix Table 3 exceeded 5 percent, strikes reduced output (as intuition suggests) but the effect is judged to be "too small" to be distinguished from zero.

For Canada, 36 of 43 industries do not show a significant impact of strikes on output. Of these 36, 14 had a (measured) positive total effect on output. In two others, average strike was negative, and the MSL was less than 5 percent. As for the U.S., these are considered anomalous cases. We attribute smallness of measured effect (of strike activity on output) is due primarily to "fragmented bargaining." In an industry where collective bargaining was industry wide, with all union-employer contracts commencing and expiring simultaneously, strikes would occur only at the (relatively infrequent) dates of contract expiration.[18] Such strikes would, in principle, completely halt an industry's production and be associated with large reductions in output. Furthermore, the high cost of such strikes would motivate bargainers to limit their frequency by negotiating relatively long contracts, and/or by instituting procedures to hold down the probability of strikes during contract negotiations and to avoid strikes during the life of a contract (Reder and Neumann, 1980). Thus, under industry wide bargaining, there would be relatively long periods of "industrial peace"--zero strike activity--punctuated by infrequent but costly "wars." This is the model described in section I, figure 1.

Fragmented bargaining is the reverse of this situation: a strike arises as a (probabilistic) outcome of a contract expiration in a bargaining unit of which there are many in a given industry, but none produces an appreciable share of the industry's output. Because of the small contribution to output by each bargaining unit, a strike in any one of them has but a small impact on industry output. This statement holds even where non-struck firms do not supply customers of those struck; where the reverse applies, the effect of a strike in a single bargaining unit on industry output is even smaller. Also, barring flukes, under fragmented bargaining, contract expirations in an industry are scattered more or less randomly through time with the result that in most months there is some small amount of strike activity, which has a corresponding (small) effect on output. Thus where fragmented bargaining prevails, "normal" innovations in strike activity has but a small effect on output, the (calculated) sign of which may well be dominated by the random component of the autoregressive process.

V. Summary and Interpretation

Our principal findings on the average cost of a strike, in three digit SIC manufacturing industries, may be summarized as follows:

(1) In 35 of the U.S. 63 industries analyzed (56 percent), the impact of strike activity on shipments was insufficient to permit rejection of the hypothesis of no effect on conventional statistical criteria. This means that in those 38 industries the average cost of a strike--as reflected in reduced output--is too small to be distinguished from zero. An analogous statement applies to Canada where in 34 of 43 industries strike cost could not be distinguished from zero.

(2) In the remaining 25 U.S. and 7 Canadian industries, the impact of strike activity (on shipments) was sufficiently large to reject the hypothesis of no effect. However among the U.S. industries, six showed a positive effect of strike activity on shipments, implying that shipments increased (rather than decreased) with strike activity, implying further that average cost per strike was negative. This result is so counter-intuitive that we regard it as an anomaly subject to further research. For the present, we lump these six industries with the 38 mentioned under (1) and treat the average cost per strike in all of them as indistinguishable from zero. For Canada, there are two industries with positive strike costs that must be "taken seriously."

(3) The average cost per strike in each of the remaining 19 U.S. (and 9 Canadian) industries was positive and sufficiently large as to be reliably distinguished from zero on conventional statistical criteria. But although reliably different from zero, these costs are "small." To call these dollar magnitudes "small"--or "large"--necessarily involves an element of arbitrariness that is not easy to defend.

Nevertheless, we believe that most readers will concur in the judgment that the strike costs we have estimated are small. Reasons for this judgment may vary inter-personally; our rationalization is as follows: in a debate on the merits of legislation intended to reduce strike activity, (we believe) our findings would be cited by those opposed to such legislation as evidence that strikes had not caused "much economic loss," and attacked or otherwise denigrated by those favoring the legislation. This rationalization is not offered as a contribution to an imaginary legislative debate, but only as a way of clarifying our interpretation of "small."

To avoid misinterpretation, we should like to spell out in more detail the precise meaning of our results: (i) we do not suggest that the cost of a strike, either to an individual firm or to its workers, is small. The evidence presented here pertains only to entire industries (in particular, three-digit SIC manufacturing industries) taken as entities. A finding of "no effect" of strikes on output is consistent with either (i) no effect of strikes on the output of the firms struck or (ii) a large adverse effect on the output of struck firms offset by a corresponding increase in production by non-struck firms in the industry. Our results indicate only that the effect on aggregate industry output is small in virtually all cases.[19]

(ii) Our estimates of industry strike cost have not taken into account the (possible) offset resulting from substitution of production across industries during a strike. Apart from this omission, the data in Table 4 are estimates of what public policy makers are concerned with when they ask "how much do strikes cost" as a possible first step in reconsideration of the laws governing collective bargaining. That these figures seem "small" suggests that, at least in manufacturing, the losses to individual bargainers are sufficient to induce them to adopt bargaining styles (protocols) that limit size and frequency of strikes to levels that generate only such (small) losses of output as we report.

It is to be emphasized that our results refer to Manufacturing only. Manufacturing output is characterized by embodiment in a tangible product, as distinguished from a service, which facilitates storage and intertemporal substitution. Estimates of strike cost, analogous to ours, for economic sectors where output is less storable and/or less transportable than in Manufacturing (e.g., Construction, Wholesale and Retail Trade, Services) might well show substantially higher cost "per unit of strike activity."

(4) So much for our findings on the general level of industry strike costs. Now let us consider the economic significance of the cross-industry differences among these costs.

To assert that "strikes don't cost much" is not to say that they do not have important economic consequences. For example, in (U.S.) Iron and Steel Manufacturing (as elsewhere), strike activity cost much less than one per cent of annual output. Yet strike costs in these industries were sufficient to motivate the bargainers in this industry to agree to binding arbitration of the terms of new contracts for a period of 10 years (1973-83).[20] Other examples where collective bargainers have made (what appear as) substantial modifications of behavior in order to lessen the burden of strike cost are not hard to find.

But if strikes cost "so little," how can desire to reduce their burden motivate what would appear to be costly modifications, especially by employers, of policies governing worker compensation, work rules and discipline? The answer lies in the unmeasured cost of "output rearrangement," avoidance of which motivates the efforts of bargainers to modify their (own) behavior.

(5) Cost of Output Rearrangement

Even if the customers of a struck firm fully replaced the strike impeded deliveries, and did so without appreciable delay, there might still be appreciable increases in purchase prices due to switching suppliers (e.g., greater transportation costs; need to buy at spot rather than long term contract prices) and/or reductions in productivity from use of imperfect substitute products. Anticipation of such costs in the event of a strike can motivate customer payment of inducements to suppliers (i.e., employers) to avoid delivery interruptions. To have the desired effect (i.e., to elicit cooperation in avoiding strikes), such inducements must be shared with the union. The modus operandi of sharing such customer inducements involves increasing of compensation and/or making pro-employee alteration of disciplinary procedures and work rules.

(b) Distinct from shifting to new sources of supply, altering the time path of deliveries can increase the cost of producing a given output stream by causing delays in completion and/or need to carry inventories of raw materials and goods in process for longer periods because of realized or anticipated interruptions to labor input. Desire to avoid losses of this kind motivates behavior aimed at strike avoidance similar to that described under (a).

Both (a) and (b) describe costs incurred to avoid losses stemming from output rearrangement (either altering the time shape of deliveries and/or adopting substitute sources of supply) with cumulated production unchanged. As argued, desire to avoid these costs serves to explain the effectiveness of the strike threat in generating strike avoiding behavior. These caveats aside, the results of this study demonstrate that the social costs of strike activity are de minimus. What losses occur seem small by any comparison.

FOOTNOTES

[1] Put differently, when intertemporal production decisions are considered, there may be costs attributable to the possibility of strikes even when no strikes actually occur. These consist of the extra inventory costs and (possibly) higher marginal cost of production during non-strike periods that result from precautions against "potential" strikes. But, while this is indisputably a cost of strike activity, it is very difficult to estimate it from recorded behavior since all firms, even non-struck ones, will be pursuing a similar policy.

[2] The expressions given in 3) are conditional expectations under the assumption of normality in the error term. If that assumption is dropped then 3) should be interpreted as the best linear predictors based on Ω_{t-1}.

[3] For a general treatment of the issues arising when expectations of several future values of a variable affect current realizations see Wallis (1980).

[4] For example: if $A(L) = I$, strike activity would have only a contemporaneous effect on output, with $\psi_j \equiv 0$ for $j > 0$. If $A(L) = I - A_1L$, current activity would be affected only by strike activity in the preceding period (both through expectations and adjustments thereto); i.e., $Z_t = A_1Z_{t-1} + \mu_t$. In this case a particular shock, μ_t, has the effect $I\mu_t = \mu_t$ in the current period; $A_1\mu_t$ in the second period, $A_1^2\mu_t$ in the third period, and so on, with the impact multiplier, ψ_i, declining geometrically through time. See Sims (1972, 1980) for a general discussion of the merits of this formulation; Hannan (1976) and Akaike (1974) provide further developments of the basic idea.

[5] The steady state gain matrix is the matrix analogue to the "long-run" multiplier effect familiar from single equation models with a lagged dependent variable; i.e., in the model $Y_t = AX_t + bY_{t-1} + \varepsilon_t$, the "short-run" multiplier is A, and the long-run effect of a change in X is $A(1 - b)^{-1}$.

[6] U.S. Department of Commerce, Bureau of the Census, Technical Documentation: Manufacturer's Shipments, Inventories, and Orders (M3-18) Unpublished Data 1958-1978, pp. 4-6.

[7] U.S. Department of Commerce, Bureau of the Census, Current Industrial Reports M3-1.8, pp. IX-X.

[8] To see this, consider an industry that consists of 100 firms, all of which "normally" produce the same output, say 100 units. Assume the sample to consist of four firms, each with a "normal" weight of 25%. Suppose that in a particular month one of the sample units is struck and produces nothing, while another sample unit produces 200 units, perhaps due to interfirm substitution; the remaining two sample units each produce 100. The Census procedure amounts to treating the two changed output levels as extremes (and therefore unrepresentative) and calculating monthly output as 10,000 units (= 49 x 100 + 49 x 100 + 1 x 0+ 1 x 200). If, however, the two sample firms with changed output levels were representative of the normal fraction of unsampled units, the correct level would be 10,000 units (= 25 x 100 + 25 x 100 + 25 x 200 + 25 x 0). In this case, the Census procedure would not misstate output.

Alternatively, suppose that interfirm substitution was less than perfect, but was diffused equally throughout the sample so that three firms produced 120 units, and one produced zero. Then the Census procedure would calculate an output of 11,880 (99 x 120 + 1 x 0); but in the event that the sampled firms truly represented the unsampled, output would have been 9,000 (75 x 120 + 25 x 0), so that the Census correction would overestimate output by 32%.

[9] Strike lengths in excess of a year which are sometimes reported in the data, would seem to suggest a collapse of the employment relation between employer and strikers, and to destroy the applicability of the concept "strike." This is especially so, where the firm has completely replaced the strikers and does not intend to deal with them further.

[10] One U.S. industry group, Wood buildings and Mobile Homes (SIC 245), had no strikes reported during the 1958-78 period. This is a small industry, and one whose definition was changed from the 1967 to the 1972 SIC classification, but nevertheless we find it odd that no strikes were reported. As one of us has personal knowledge of one strike in this industry, we suspect that such strikes as may have occurred were recorded in another industry.

[11] Expressing man-days lost in units of 10,000, the standard errors of the strike process (in the U.S.) ranged from .10 (Floor Covering Mills) to 8.99 (Motor Vechicles and Parts) with an average of 1.9 . For Canada, the distinct variances are lower. The results in Table 4 correspond on average then to an innovation of about .5 standard errors for the U.S., and about .7 standard errors for Canada.

[12] In these data, a strike involving 10,000 lost man-days is a middle sized strike in the U.S., corresponding to approximately 333 workers out for 30 working days, and a somewhat smaller strike in Canada, roughly 370 workers. In most industries 30 days is equivalent to a strike of mean duration at one plant. Man-days lost refers to calendar man-days.

[13] Although independent of one another, these two "explanations" are in no sense incompatible.

[14] As a matter of fact, in both U.S. and Canadian manufacturing for unknown reasons, strikes are more likely to start in the latter part of a month than in the beginning half. This accentuates the likelihood of spurious positive contemporary correlation of output and strike activity.

[15] An average strike, for this purpose, is defined as total man-days idle divided by total strikes over the entire sample period, 1958-77 for the U.S., and 1960-76 for Canada.

[16] Our measure is ambiguous in that the denominator is realized output rather than "output that would have been produced in the absence of strikes." Although the latter concept is more appealing intuitively, the difference between the two concepts is trivial because of the small fraction of output lost on account of strikes.

[17] These numbers are taken from Appendix C of Analysis of Work Stoppages 1959, Bureau of Labor Statistics, G.P.O., 1962 which chronicles the steel strike.

[18] We assume that wildcat or other strikes during the lives of contracts are quantitatively unimportant and ignore them accordingly.

[19] Even if output losses in a given industry were small or zero, there would still be resource costs of reallocating output intertemporally (e.g., increased use of overtime labor and extra costs associated with peak load rates of equipment utilization), or changing suppliers.

[20] Reder and Neumann (1980), p.

REFERENCES

Akaike, H. "Markovian Representation of Stochastic Processes and its Application to the Analysis of Autoregressive Moving Average Processes," Annals of the Institute of Statistical Mathematics, V. 26 (1974) pp. 363-387.

Ashenfelter, Orley and George E. Johnson. "Bargaining Theory, Trade Union and Industrial Strike Activity," American Economic Review, V. 59 (March 1969), pp. 35-49.

Hannan, E.J. "The Indentification and Parametrization of ARMAX and State Space Forms," Econometrica, V. 44 (1976) pp. 713-722.

Hicks, John R. The Theory of Wages, MacMillan: London (1932).

Kennan, John. "The Effect of Unemployment Insurance Payments on Strike Duration," University of Iowa working paper (1980).

Muth, John F. "Rational Expectations and the Theory of Price Movements," Econometrica, V. 29 (July, 1961) pp. 315-335.

Neumann, George R. "The Predictability of Strikes: Evidence from the Stock Market," Industrial and Labor Relations Review, V. 33, No. 4, (July, 1980) pp. 525-535.

Rees, Albert. "Industrial Conflict and Business Fluctuations," Journal of Political Economy, V. 60, no. 5 (October 1952), pp. 371-382.

Reder, Melvin W. "Unions, Wages, and the Cost of Strikes: The Blackjack Theory," to be submitted for publication, 1982.

Reder, Melvin W. and George R. Neumann. "Conflict and Contract: The Case of Strikes," Journal of Political Economy, V. 88, No. 5 (October 1980) pp. 867-886.

Scully, Gerald W. "Business Cycles and Industrial Strike Activity," Journal of Business, .

Sims, Christopher A. "Money, Income and Causality," American Economic Review, V. LXII, No. 4 (September, 1972) pp. 540-552.

________________. "International Evidence on Monetary Factors in Macroeconomic Fluctuations," University of Minnesota discussion paper 80-137 (September, 1980).

U.S. Department of Commerce, Bureau of the Census, Technical Documentation: Manufacturer's Shipments, Inventories, and Orders (M3-1B) Unpublished Data 1958-1978.

________________. Current Industrial Reports M3-1.8.

U.S. Department of Labor, Bureau of Labor Statistics, Analysis of Work Stoppages, 1959, G.P.O., 1962.

Wallis, Kenneth F. "Econometric Implications of the Rational Expectations Hypothesis," Econometrica, V. 48, No. 1 (January, 1980) pp. 49-74.

HC Reder, M.W.
117
.06 An analysis of strikes in
.0675 Canadian manufacturing
no.1/84 industries.